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[Article: "Regulations on Implementing China's Technology Contract Law, Approved By State Council 15 Feb 89, Promulgated by State Science and Technology Commission 15 Mar 89"]

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[Text] Section I. General Principles

Article 1. These regulations were formulated in accordance with regulations in Article 54 of the "Technology Contract Law of the People's Republic of China" (abbreviated hereinafter as the Technology Contract Law).

Article 2. The legal persons mentioned in Article 2 of the Technology Contract Law refer to organ legal persons, institutional legal persons, social group legal persons,and enterprise legal persons.

The citizens mentioned in Article 2 refer to people who are citizens of the People's Republic of China.

Associations, organs, and other economic group legal persons can be one party in establishing technology contracts.

Article 3. Technology achievements mentioned in the Technology Contract Law refer to the use of scientific and technical knowledge, information, and experience to make products, techniques, materials, and improvements in them, as well as other technology programs.

Article 4. The tasks to be implemented by each unit mentioned in Article 6 of the Technology Contract Law refer to:

1) Working personnel who assume responsibility for scientific research and technical development in their unit or who perform the duties of their own positions;

2) Personnel who have retired, resigned, or changed jobs who within 1 year of leaving their former unit continue to be responsible for scientific research and technical development projects or perform the duties of their own positions;

The material technology conditions mentioned in Article 6 of the Technology Contract Law refer to capital, equipment, non-public technical information and data provided by a unit. However, they are not restricted to the use of material technologies and conditions provided by the unit, nor to repayment of capital or payment of use fees on the basis of prior agreements.

The technical achievements completed by personnel who change jobs and implement tasks of their former unit and which utilize the material and technical conditions of their current unit can be used by both the former unit and the current unit.

Article 5. The use rights and transfer rights over non-patented technical achievements mentioned in Article 32 of the Technology Contract Law refer to special rights to use and transfer non-patented technical achievements on the basis of legal stipulations or contractual agreements between parties. Use rights refer to the rights to utilize this non-patented technical achievement for the goal of production management. Transfer privileges refer to the rights to provide and assign this non-patented technical achievement to another person by means of a technology contract.

Article 6. The non-patented technologies mentioned in Article 34 of the Technology Contract Law include:

1) Technical achievements for which no patent applicaiton has been made;

2) Technical achievements for which no patent applicaiton has been received;

3) Technical achievements which are not awarded patent rights under the Patent Law.

Article 7. The individuals who complete the technical achievements mentioned in Article 6 of the Technology Contract Law refer to individuals who make either individual or joint creative contributions to the technical achievement. They do not include personnel who merely provide capital, equipment, materials, or experimental conditions, personnel involved in organization and management, personnel who assist in compiling diagrams, taking care of information, translating documents, or other auxiliary service personnel.

The technical achievement documents mentioned in that article refer to patent applications, science and technology award applications, scientific and technical achievement registrations, and other

certificates and documents which specify the identity of those who make technical achievements and receive credit.

Article 8. Technologies which concern national safety or major interests and should be classified for which technical contracts have been established should be handled according to the law and relevant state regulations after the relevant S&T secrecy organs determine the level of classification.

Article 9. The non-patented technical achievements of major significance mentioned in Article 7 of the Technology Contract Law refer to technical achievements which have major economic benefits or social benefits, or which have been checked and approved by the State Science and Technology Commission as conforming to first place invention awards or first place scientific and technical progress awards.

Section II. Establishing, Fulfilling, Modifying, and Terminating Technology Contracts

Article 10. The establishment of a technology contract should be done through consultation and agreement by the parties.

The parties can reach agreement regarding the secrecy of printed materials for transferring technical information and data prior to establishing the contract. Failure by the parties to reach unanimity regarding the establishment of the contract does not affect the effectiveness of the secrecy agreement.

Article 11. The parties can establish a single contract to link several scientific and technical projects or several types of technical contracts, or they can establish several separate contracts.

Article 12. When legal persons establish a technology contract, a legal representative or authorized personnel should sign or affix their seal, and they should affix the official seal of the legal person or special contract seals.

When citizens establish a contract, they should sign their own names or affix their own seals.

Article 13. Establishment of the following types of technology contracts should be approved by the relevant organs or fulfill the required procedures:

1) Contracts signed for major scientific and technical projects which are included in state plans or in plans of provinces, autonomous regions, or cities directly under central authorities should be examined and approved by administrative departments of the State Council or administrative departments in the province, autonomous region, or municipality directly under central authorities.

2) Established technology contracts which require secrecy because their content concerns national security or other major interests should be examined and approved by the organ which assigns the level of secrecy.

3) Contracts by units under ownership by the whole people which involve the transfer of patent rights or patent application rights should be examined and approved by their higher authorities. Contracts for the transfer of patent application rights or transfer of patent rights become effective after registration and announcement by the China Patent Bureau.

4) Contracts established for projects involving combustibles, explosives, high pressures, high vacuums, acute toxins, structures, medicines, public sanitation, radioactivity and other high risks or which concern personal safety and social public interests should be handled according to the relevant regulations of the state.

For parties which establish contracts that have been approved by the relevant organs or which have fulfilled the required procedures prior to the various items in the preceding clauses, the contracts will be established after the parties sign and affix their seals. For those which have not received approval from the relevant organs or fulfilled the required procedures at the time the contract is established, the contract will be established after approval is received from the relevant organs or the required procedures are fulfilled.

Article 14. Technology contract costs, remuneration, and use fees should be based on consultation and negotiation by the parties on the basis of the economic benefits and social benefits, the cost of technical research and development, the degree of development of industrialization of the technical achievements, the rights which the parties enjoy and the burdens which are their responsibility.

Costs, remuneration, and use fees include non-technical items and should be accounted for item-by-item.

Article 15. The form of payment of the costs, remuneration, and use fees of technical contracts should be based on consultation and negotiation by the parties. They can be calculated in their entirely at one time and paid in their entirety at one time, or they can calculated in their entirety at one time and paid in scheduled installments, or there can be an arrangement in which they are paid via deductions or through deductions added to entry fees paid in advance.

Those who agree to pay via deductions can have a specific proportion deducted on the basis of product prices, the additional value of output, profits, or product sales volume from the applicaiton of a patent and the use of non-patented technologies, and it can be calculated on the basis of any other agreed upon arrangement. The proportion to be deducted for payment can be set at a fixed proportion, a proportion with increases annually, or a proportion which decreases annually.

For those who agree to pay via deductions, the parties should agree in their contract to the method of consulting the relevant accounting accounts.

Article 16. The parties to a technology contract can agree to the payment of earnest money. If the party which pays the earnest money does not fulfill the contract, they must return the earnest money. If the party which receives the earnest money does not fulfill the contract, they must return double the earnest money. After the contract is fulfilled, the earnest money should be returned or it should be used as compensation for costs, remuneration, or use fees.

Article 17. The parties to a technology contract can agree to a property mortgage. If the mortgagor does not fulfill the contract, the mortgagee can mortgage the property or convert the property mortgage for sale for preferential paying off after assessment of value in monetary terms. After the contract is fulfilled, the mortgaged property should be returned.

Property whose circulation is restricted by laws or regulations cannot be mortgaged.

Article 18. Technology contracts for which a third party serves as guarantor can agree to guarantee clauses in the contract or another guarantee contract can be established.

Contracts which agree to guarantee clauses are established after both parties and the guarantor sign the contracts and affix their seals. Contracts with attached guarantee contracts become effective after the guarantor and the person being guaranteed sign the contract and affix their seals.

The guarantor is a person with a relationship of obligation to fulfill the contract for the person being guaranteed. When the person being guaranteed does not fulfill the obligations of the contract, the guarantor has the responsibility of fulfilling the contract obligations or the joint responsibility of compensating for losses. However, the guarantor is only responsible for that part for which they have assumed taken responsibility, and after the guarantor fulfills the contract obligations or compensates for losses, they have the right to request compensation from the person being guaranteed.

Units and individuals cannot serve as guarantors if they cannot independently dispose of the corresponding property or lack the ability to fulfill the contract.

Article 19. The consignment document mentioned in Article 13 of the Technology Contract Law should include the following: the name or organizational name of the representative, the agent business, the restrictions on consignment rights, the time period, and other related items.

Article 20. The intermediary organ mentioned in Article 14 of the Technology Contract Law refers to an organization which provides services to convert technical achievements into commodities.

The intermediary organ can use technology intermediary contracts to facilitate technology contracts which establish relationships and intermediary activities between one of the parties and a third party and promote complete fulfillment of the contract, and to organize or participate in the industrialization and development of commodity products of technical achievements. They can assume responsibility for contracting to establish representative businesses and work to mediate contract disputes, and provide legal consulting, technical advisories, market surveys, and information services.

Article 21. The parties should agree to clauses in technology contracts on the basis of the relevant regulations in Article 12 of the Technology Contract Law and this article.

In cases where the examination, acceptance, and approval, the term of fulfillment, and the site of fulfillment are unclear, the parties should resolve them through consultations. Those who cannot reach agreement through consultations should apply the following regulations according to the content of the contract:

1) Those technical achievements for which the examination, acceptance, and approval are unclear should be fulfilled according to state standards or special technical standards. Those without approval should be fulfilled according to the general requirements which conform to and are used in that business.

2) In cases in which the time period for fulfillment is unclear, the party responsible for the obligations can fulfill its obligations to the other party at any time, and the party which has the authority can require that the other party fulfill its obligations at any time, but they should give the other party sufficient time for preparation.

3) In cases where the site of fulfillment is unclear, technical development contracts should be fulfilled at the location where the research is developed, technical transfer contracts should be fulfilled at the location of the recipient of the transfer, technical consulting contracts should be fulfilled at the location of the advisor, and technical service contracts should be fulfilled at a commissioned site.

Article 22. When the parties agree to a penalty fund, the penalty fund should be seen as a compensation fund for violations of the technology contract. After the party which violates the contract pays the penalty fund, losses can no longer be computed or compensated. However, this does not include situations in which the contract specifically contains an agreement that when the losses to one party due to violation of the contract by the other party exceed the penalty fund they should compensate for that portion not covered by the penalty fund.

When the parties do not agree to a penalty fund and methods for calculating the amount of compensation for losses in the contract, the amount of compensation paid to one party for its losses due to the other party violating the contract would equal the calculated actual losses. This amount of compensation should be equivalent to losses from reduced income by one party or additional expenditures.

When the parties agree in the contract that the penalty fund must not exceed the sum of the cost, remuneration, and use fees of the contract, the method used to calculate the amount of compensation for losses should not appear to be unfair.

Article 23. When one party encroaches upon the patent rights, patent application rights, patent implementation rights, non-patented technology use rights and transfer rights of the other party, or when secrecy obligations are violated, besides the regulations for assuming responsibility for violating the contract in Article 22 of these regulations, they should stop the encroachment, take remedial methods, and compensate for losses. The amount of compensation should equal the illegal gains during the period of encroachment by the encroaching party or the actual losses of the party subjected to encroachment during the period of encroachment upon their rights.

Article 24. The force majeure mentioned in Article 20 of the Technology Contract Law refers to unexpected, unavoidable, and insuperable objective conditions due to natural factors or social factors. The parties can agree to the scope of the force majeure in the contract.

When one party cannot fulfill its contractual obligations because of a force majeure, they are excused from responsibility for fulfilling the contract. However, when a force majeure causes only part of the contract not to be fulfilled, their obligation to fulfill the remainder of it is not excused.

A party which is unable to fulfill its contractual obligations because of a force majeure should immediately notify the other party and produce a certificate of inability to fulfill the contract within a reasonable time period. The parties should adopt appropriate measures to reduce the losses.

Article 25. The meaning of the items in Article 21 of the Technology Contract Law concerning the non-effectiveness of technology contracts is:

1) "Violations of the law and regulations" refer to behavior which is explicitly prohibited by laws and regulations in establishing the contract or in conducting activities according to the contract.

2) "Illegal monopolization of technologies and obstruction of technical progress" refers to the use of contract clauses to restrict one party from engaging in new research and development on the basis of technologies included in the contract tender, restricting one party from absorbing technologies from other channels, or obstructing one party from fully implementing patents and utilizing non-patented technologies according to the pattern of the contract on the basis of market demand.

3) "Harming the legitimate interests of another person" refers to behavior which encroaches upon the patent rights, patent application rights, patent implementation rights, non-patented technology use rights, and transfer rights of the other party or a third party, or invention rights, discovery rights, and rights to other scientific and technical achievements.

Article 26. For a contract which conforms to one of the situations listed in Article 21 of the Technology Contract Law, the parties or a person with a relationship of personal interest can apply to industrial and commercial administrative management organs to announce that the contract is no longer in effect. The parties or a person with a relationship of personal interest also can apply to the People's Court to announce that the contract is no longer in effect.

When administrative management organs discover a contract which conforms to the previous clause during implementation of their work, they have the right to inspect and deal with it. However, in cases involving illegal monopolization of a technology, obstruction of technical progress, or encroachment on the technical rights and interests of another person, industrial and commercial administrative management organs should entrust the local science and technology commission with making a conclusion and then dealing with it. Cases which involve encroachment upon a patent should be entrusted to patent management organs to make a conclusion and then deal with it.

Article 27. After an industrial and commercial administrative management organ or People's Court announces that a technology contract is no longer in effect, the party which is responsible for the contract not being in effect should compensate the other party for the losses which they suffer as a result of the contract no longer being in effect. When each of the parties has equal responsibility for the contract no longer being in effect, they shall bear a corresponding responsibility.

Article 28. For technology contracts which have been announced as no longer being in effect because of encroachment on the patent rights, patent application rights, patent implementation rights, non-patented technology use rights, and transfer rights, or invention rights, discovery rights, and rights to other technical achievements of another party, the person who is encroaching on the rights should be ordered to cease the encroachment, offer an apology, eliminate the effects, and compensate for losses.

When a contract which encroaches on the patent rights, patent application rights, or patent implementation rights of another party is announced to no longer be in effect, that which has not been fulfilled should not be fulfilled, and that which is being fulfilled must cease being fulfilled.

When a contract which encroaches on the non-patented technology use rights and transfer rights of another party is announced to no longer be in effect, the recipient of the non-patented technology can continue to utilize this technology, but it should pay reasonable use fees to the person holding the right.

For contracts which encroach upon the invention rights, discovery rights, other scientific and technical achievement rights and other technical achievement completion rights of a person, after it is announced that some of the clauses are no longer in effect, this does not affect the effectiveness of the remaining portion, and the remaining portion is still in effect.

Article 29. When any of the following situations is discovered, one of the parties has the right to request the People's Court or arbitration organ to modify or cancel the technology contract:

1) The parties have a serious misunderstanding of the contract tender or the rights over technical achievements;

2) An obvious loss of fairness in costs, remuneration, or use fees;

Article 30. When the parties discuss modification of a technology contract,they should reach written agreement concerning addition to, reductions in, or modifications of contract clauses and the methods for dealing with the losses they cause.

When the parties discuss and agree to contract termination, they should reach a written agreement on the date for advance termination of the contract and methods for dealing with the losses this causes.

Modification or termination of contracts which have been approved by the relevant organs requires approval of the organs which originally gave approval. Modification or termination of contracts which have been registered with technology contract registration organs should be recorded with the original registration organ.

Article 31. In cases in which it is discovered that the situation is one listed in Article 24 of the Technology Contract Law, that is, when the fulfillment of the technology contract becomes unnecessary or impossible, one of the parties has the right to terminate the contract. They should, however, notify the other party, and their obligation to fulfill the contract ends on the day the notification is issued.

Notification of contract termination must be in written form and explain the actual situation which has made contract fulfillment unnecessary or impossible and provide the relevant evidence.

Article 32. When a technology contract is modified or terminated, the party in error should compensate the other party for the losses they incur as a result. When both parties have made an error, each should assume the corresponding responsibility.

Article 33. Technology contracts are terminated for any of the following reasons:

1) The obligations of the contract are completely fulfilled;

2) It has been announced that the contract is no longer effective or has been canceled;

3) The contract has been terminated;

4) The contract is terminated for any other reason.

When a technology contract is terminated, the parties can agree that one or both parties have an obligation to maintain secrecy concerning the relevant technical information and data for a specific period of time. Those who violate secrecy obligations should compensate the other party for losses they incur as a result.

Article 34. When one party to a technology contract transfers part or all of its obligations to a third party, they should obtain the agreement by the other party and must not illegally seek benefits by means of transferring contract rights and obligations.

Section III. Technical Development Contracts

Article 35. The new technologies, new products, new techniques, new materials, and their systems mentioned in Article 27 of the Technology Contract Law refer to products, techniques, materials, and their systems, and other technical programs which the parties have not obtained at the time the contract is established. However, when technically there have been no newly-created product modifications, this does not include inspections, testing, and applications of technical revisions, adjustments of materials mixtures, and inspection of technical achievements.

Article 36. The establishment of technical development contracts should have the necessary research and development funds, basic facilities, technical information and data, and other conditions, carry out the required feasibility debates, select appropriate research and development programs, and avoid redundant research and development.

The establishment of technical development contracts for scientific and technical items which are included in state plans must conform to the requirements of plan and project task documents. The establishment of contracts for other items should conform to the relevant technical policies.

Article 37. In general, technical development contracts should include the following clauses:

1) The name of the item;

2) The content, form, and requirements of the tendered technology;

3) Research and development plans;

4) Research and development funds or the amount of item investments and patterns for paying and calculating them;

5) The property rights for equipment, devices and materials, and data purchased using research and development funds;

6) The time limitations, location, and patterns for contract fulfillment;

7) Secrecy of technical information and data;

8) Burden of responsibility for risks;

9) Ownership and division of technical achievements;

10) Standards and measures for examination and acceptance;

11) Patterns for calculating and paying remuneration;

12) Methods for calculating a penalty fund or the amount of compensation for losses;

13) The content of technical cooperation and technical guidance;

14) Methods for resolving disputes;

15) Explanations of terms and terminology.

Contracts established for scientific and technical items which are included in state plans should have attached a project planning document, task document, and document of approval by administrative organs.

Article 38. The research and development funds mentioned in Article 28 of the Technology Contract Law refer to the costs required to complete the research and development work. Excluding other agreements in the contract, the consignor should provide all of the research and development funds.

The parties should agree in the contract to a method for calculating research and development funds. For contracts which agree to actual payments, whenever research and development funds are inadequate, the consignor should compensate with payments; whenever there are surplus research and development funds, the research and development party should repay them in full. When the contract agrees to contractual responsibility for their utilization, the surplus funds belong to the research and development party. Insufficient funds should be covered by the research and development party itself. When the contract contains no agreement on methods for calculating funds, they should be dealt with according to contractual responsibility for utilization.

Article 39. The remuneration mentioned in Article 28 of the Technology Contract Law refers to use fees for research and development achievements and to subsidies for scientific research by research and development personnel. For contracts which agree to use a specific proportion of research and development funds as a use fee and scientific research subsidy, the remuneration does not have to be listed separately.

Article 40. The parties can agree to use one or more of the following patterns for turning over research and development achievements, but the number should not exceed a reasonable range:

1) Product designs, technical regulations, materials mixtures, and other blueprints, articles, reports, and other technical documents;

2) Magnetic tapes, disks, and computer software;

3) New varieties of animals or plants, and varieties of microorganisms and fungi;

4) Samples and prototypes;

5) Complete sets of technical equipment.

Article 41. The consignor assigned a development contract has the right to inspect the situation of contract fulfillment by the research and development party and the utilization of research and development funds, but they must not obstruct normal work by the research and development party.

The research and development party has the right to request that the consignor supplement the required background information and data, but it should not exceed the scope required by contract fulfillment.

Article 42. When the consignor entrusted with a development contract does not fulfill the contract, they should pay a penalty fund or compensate for losses as stipulated in Article 29 of the Technology Contract Law.

When the consignor delays in remitting research and development funds, and thereby causes a stoppage or losses due to delay of research and development work, the research and development party does not bear responsibility. When the consignor has not paid research and development expenditures fund or remuneration after 2 months, the research and development party has the right to terminate the contract, and the consignor should return the technical information, pay the required remuneration, and compensate the research and development party for losses incurred as a result.

When the consignor fails to provide technical information, original data, and cooperative items as agreed to in the contract, or when there are major shortcomings with the technical information, original data, and cooperative items that are provided which cause stoppages, losses due to delays, or failure of research and development work, the consignor should assume responsibility. If the consignor does not provide the technical information, original data, and cooperative items within 2 months, the research and development party has the right to terminate the contract, and the consignor should compensate the research and development party for losses incurred as a result.

When the consignor has not received research and development achievements within 6 months, the research and development party has the right to penalize the research and development achievements. The income received should be returned to the consignor after deducting the remuneration, penalty fund, and storage fees. When the income is insufficient to compensate for the relevant remuneration, penalty funds, and storage fees, they have the right to request that the consignor compensate for the losses.

Article 43. When the research development party consigned in a development contract fails to fulfill the contract, they should pay a penalty fund or compensate for losses according to the stipulations in Clause 2 of Article 29 of the Technology Contract Law.

When the research and development party fails to implement the research and development work according to plan, the consignor has the right to request that the research and development plan be implemented and that compensatory measures be adopted. In cases in which the research and development fails to implement the research and development plan within 2 months, the consignor has the right to terminate the contract. The

research and development party should return the research and development funds and compensate the consignor for the losses incurred as a result.

When the research and development party uses the research and development funds for purposes other than contract fulfillment, the consignor has a right to terminate it and to request that they return the corresponding research and development funds for use in research and development work. When the result is a stoppage, losses due to delay, or failure in research and development work, the research and development party should pay a penalty fund or compensate for losses. If the research and development party has not returned the funds used for research and development work within 2 months after being urged to move forward by the consignor, the consignor has the right to terminate the contract. The research and development party must return the research and development funds and compensate the consignor for losses suffered as a result.

For mistakes in research and development which result in research and development achievements that do not conform to agreements in the contract, the research and development party should pay a penalty fund or compensate for the losses. If the result is failure in the research and development work, the research and development party should return part or all of the research and development funds, and pay a penalty fund or compensate for the losses.

Article 44. The investments mentioned in Article 30 of the Technology Contract Law refer to inputs of capital, equipment, materials, sites, experimental conditions, technical information and data, patent rights, non-patented technical achievements, and other forms made to the research and development project by the parties to a research and development contract. Investments involving things other than capital should be converted to an equivalent amount to clarify the proportion of the investments accounted for by the parties.

Article 45. Participation in research and development work as mentioned in Article 30 of the Technology Contract Law refers to design, technology, experiment, trial manufacture and other research and development work based on an agreed-upon plan and a division of labor for jointly carrying out or separately assuming responsibility.

In contracts in which one of the parties provides capital, equipment, materials, and other material conditions and assumes responsibility for auxiliary cooperative items and another party conducts the research and development work, this is not a cooperative development contract and should be dealt with as a consigned development contract.

Article 46. The parties to a technology development contract can establish a guidance organ composed of representatives of both parties for decision-making concerning major issues in the research and

development work and for coordinating and organizing research and development activities to assure smooth progress in research and development work.

Article 47. When the parties to a technical development contract do not fulfill the contract, they should pay a penalty fund or compensate for losses as stipulated in Article 31 of the Technology Contract Law.

When one party fails to make the investment or does not fulfill other agreed-upon obligations within 2 months, the second party or another party has the right to terminate the contract. The one party should compensate the other party or any other party for losses which they suffer as a result.

Article 48. Research and development achievements which are completed through fulfillment of a technology development contract should be examined and accepted according to examination and acceptance standards and methods agreed upon in the contract. In cases where there is no agreement on examination and acceptance in the contract, appraisals can be organized according to the usual requirements applied.

Article 49. During examination and acceptance of a research and development achievement, each of the parties has the right to obtain the technical data and the experimental reports and data required to implement this technical achievement, to request that the other party carry out the necessary technical guidance, and assure that the technical achievement includes the conditions for implementation. When the contract ends, however, another contract should be established when one party still requires that the other party or another party continue to provide technical services.

Article 50. For technical achievements developed through consigned development or cooperative development, based on stipulations in Article 32 of the Technology Contract Law or on contractual agreements, patent rights or non-patented technical achievement use rights and transfer rights are the property of both parties, and the joint owners should agree to a method for allocating the benefits. When the joint owners have not come to an agreement, any of the parties has the right to implement the patent or utilize a non-patented technical achievement. The benefits which accrue as a result belong to the implementing and utilizing party. However, when one party transfers a technology, it must obtain the agreement of the other party or any other party, and the benefits which accrue as a result belong equally to all of the parties.

Article 51. For the technical achievements researched and developed by units which establish a consigned development contract for projects included in state plans by state administrative departments or project supporting departments, state administrative departments or project supporting departments have the right to make decisions on implementing the technical achievement.

Article 52. The responsibility for risks mentioned in Article 33 of the Technology Contract Law should include these conditions:

1) The topic has a sufficient degree of difficulty given existing technical levels;

2) The research and development party has made an objective effort and experts in this field consider the research and development failure to be a reasonable failure.

Section IV. Technology Transfer Contracts

Article 53. Technology transfer contracts as mentioned in Article 34 of the Technology Contract Law include:

1) Patent rights transfer contracts, which refers to the establishment of contracts in which a patent owner serves as the transferring party and transfers the ownership rights or holding rights for a discovery or invention patent to a recipient party, with the recipient paying an agreed-upon cost.

2) Patent application rights transfer contracts, which refer to establishment of contracts in which the transferring party transfers the patent applicaiton rights for a discovery or invention patent to a recipient party, with the recipient paying an agreed-upon cost.

3) Patent implementation permission contracts, which refer to establishment of contracts in which the patent owner or person assigned by them acts as the transferring party in permitting the recipient to implement the patent within an agreed-upon scope, with the recipient paying an agreed-upon use fee.

4) Non-patented technology transfer contracts, which refer to establishment of contracts in which a transferring party provides the recipient with their non-patented technical achievements and which clarifies the mutual use rights and transfer rights for a non-patented technical achievement, with the recipient paying an agreed-upon use fee.

Article 54. Technology transfer contracts should include the transfer of specific and existing patent rights, patent application rights, patent implementation rights, non-patented technology use rights, and transfer rights, but should not include establishment of contracts for the transfer of technical achievements which have not yet been researched and developed or the transfer and receipt of knowledge, technologies, experience, and information unrelated to patented or non-patented achievements.

Article 55. The scope of patent implementation or the use of non-patented technologies mentioned in Article 35 of the Technology Contract Law refers to the time limits for patent implementation and the region

and pattern for the implementation of patented or non-patented technologies. However, the parties should not use contract clauses to agree to unreasonable restrictions listed in Clause 2 of Article 25 of these regulations which restrict technical competition and technical development.

Article 56. Contracts for the transfer of patent rights generally should include the following clauses;

1) The name of the item;

2) The name and content of inventions and innovations;

3) The date of patent application, application number, patent number and time period in which the patent rights are in effect;

4) Conditions for patent implementation and implementation permission;

5) A list of technical information and data;

6) Costs and patterns of payment;

7) Methods for calculating penalty funds or amount of compensation for losses;

8) Methods for resolving disputes.

Article 57. Patent application rights transfer contracts generally should include the following clauses:

1) The name of the item;

2) The name and content of inventions and innovations:

3) The nature of the inventions and innovations;

4) A list of technical information and data;

5) The responsibility for patent application rejection;

6) Costs and the pattern for paying them;

7) Methods for calculating penalty funds or the amount of compensation for losses;

8) Methods for resolving disputes.

Article 58. When the transferring party has already implemented an invention or innovation prior to establishing patent right transfer

..acts and patent applicaiton right transfer contracts, excluding other agreements in the contract, the transferring party should cease implementation after the contract is established.

Article 59. Patent right transfer contracts and patent application right transfer contracts do not affect the ability of the transferring party to establish patent implementation permission contracts or non-patented technology transfer contracts prior to the establishment of the contract. Excluding other agreements in the contract, the recipient of a patent right transfer contract or patent application rights transfer contract assumes responsibility for the patent rights and obligations agreed to in the original patent implementation permission contract or non-patented technology transfer contract.

Article 60. The primary obligations of the transferring party in a patent right transfer contract are to transfer ownership or holding of patent rights agreed to in the contract to the recipient and assure that the patent rights for this item are true and effective.

The primary obligations of the recipient are to pay the agreed-upon costs to the transferring party as agreed to in the contract.

Article 61. The primary obligations of the transferring party in a patent applicaiton rights transfer contract are to transfer the rights to apply for a patent for inventions and innovations agreed to in the contract, and to provide applicaiton rights and the technical information and data required for implementation of the discovery and innovation.

The primary obligations of the recipient party are to pay the costs to the transferring party as agreed to in the contract.

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[Text] Article 62. When the transferring party in a patent rights transfer contract does not fulfill the contract or delays in handling the procedures for transferring the patent rights, or when the recipient does not fulfill the contract or delays in paying the costs, they should pay a penalty fund or compensate for losses.

When the transferring party does not handle the patent right transfer procedures for 2 months or when the recipient does not pay the costs for 2 months, the other party has the right to terminate the contract. A party which violates the contract should compensate the other party for losses incurred as a result.

Article 63. When the transferring party in a patent application rights transfer contract does not fulfill the contract or delays in providing technical information and data, or when the technical information and

data provided are insufficient to make it possible for normal specialized technical personnel in this field to implement the invention or innovation, they should pay a penalty fund or compensate for the losses.

When the recipient party does not fulfill the contract or delays in paying the costs, they should pay a penalty fund; those who do not pay the costs or do not pay the penalty fund should return the patent applicaiton rights, return the technical information, and pay a penalty fund or compensate for the losses.

When the transferring party has not provided the relevant technical information and data for the invention or innovation within 2 months, or when the recipient does not pay the costs within 2 months, the other party has the right to terminate the contract, and the party which violates the contract should compensate the other party for the losses incurred as a result.

Article 64. When the patent for a invention or innovation by the recipient in a patent applicaiton rights transfer contract is rejected, they should not request the return of the costs, but this does not include cases in which the transferring party encroaches upon the patent rights or patent application rights of another party.

Article 65. After a patent rights transfer contract is established, if it is announced that the patent rights for this item are no longer effective, the transferring party should return the costs.

Article 66. A patent implementation permission contract generally should include the following clauses:

1) The name of the item; 2) The name and content of the invention or innovation; 3) The scope of permission for implementation; 4) The date of the patent application, application number, patent number, and the time period during which the patent rights are in effect; 5) Technical information and data and their secret items; 6) The content of technical services; 7) Standards and patterns for examination and acceptance; 8) Utilization fees and patterns for paying them; 9) Methods for calculating penalty funds or the amount of compensation for losses; 10) Provision and shared use of later improvements; 11) Methods for resolving disputes; 12) Explanations of terms and terminology.

Article 67. When parties establish patent implementation permission contracts for jointly-owned patents, they should obtain the agreement of the person who holds the patent rights. For patent implementation permission contracts established under decisions by the China Patent Bureau to give compulsory permission for implementation, the recipient has the right to joint implementation and does not have the right to permit another party to implement them.

Article 68. The transferring party in patent implementation permission contracts should maintain the patent in force for the effective period of the contract. When the patent rights expire during the effective period of the contract, the contract expires at the same time, and the transferring party should pay a penalty fund or compensate for losses. When a patent right is announced to be no longer in effect, the transferring party should compensate for the losses incurred by the recipient as a result, but use fees which have already been paid are not returned.

Article 69. Patent implementation permission contracts can include monopoly implementation permission, assigned implementation permission, common implementation permission, and other forms. Production permission, use permission, and marketing permission can be adopted for product inventions or the utilization of new types of patents.

The form of permission in the preceding clause can include re-transfer of permission by the recipient party. The re-transfer of permission should be common implementation permission.

Article 70. The parties to a patent implementation permission contract should fulfill the primary obligations in Article 37 of the Technology Contract Law and the various obligations agreed upon in the contract.

Besides fulfilling the obligations stipulated in the preceding clause, the transferring party in an assigned implementation permission contract should not establish a patent implementation permission contract for the same patent with a third party within the scope of the recipient party's implementation patent.

Besides fulfilling the obligations stipulated in Clause 3 of this Article, the transferring party in a monopoly implementation permission contract should not implement this patent within the scope of the previously-permitted recipient's implementation patent.

Article 71. The parties can establish a mutual implementation permission contract which agrees to free mutual implementation of another party's patent, or they can agree to provide the other party with suitable compensation based on the benefits from implementation of the patent.

Article 72. When the transferring party in a patent implementation permission contract does not fulfill the contract, they should pay a penalty fund or compensate for losses as stipulated in article 40 of the Technology Contract Law.

When the transferring party fails to remit technical data and provide technical guidance within 2 months, the recipient party has the right to terminate the contract. The transferring party should return the use fees and compensate the recipient party for losses incurred as a result.

When the transferring party in a monopoly implementation permission contract or an assigned implementation permission contract exceeds the scope of patent implementation agreed upon in the contract, or when it establishes a patent implementation permission contract with another

party which falls within the scope of patent implementation already permitted to the recipient party, it should stop behavior which violates the contract and pay a penalty fund or compensate for losses.

Article 73. When the recipient party in a patent implementation permission contract fails to fulfill the contract, it should pay a penalty fund or compensate for losses as stipulated in article 41 of the Technology Contract Law.

When the recipient party has not paid the use fee within 2 months, the transferring party has the right to terminate the contract, and the recipient party should remit a use fee and compensate the transferring party for losses incurred as a result.

When patent implementation by the recipient party exceeds the scope agreed upon in the patent, or when they establish a re-transfer permission contract without authorization by the transferring party, they should stop the behavior which violates the contract and pay a penalty fund or compensate for losses.

Article 74. A non-patented technology transfer contract should include the following clauses: 1) The name of the item; 2) The content, requirements, and degree of industrialized development of the non-patented technology; 3) Technical information and data, and the time limits, site, and pattern for its provision; 4) The scope of technical secrecy and time period of secrecy; 5) The scope for utilization of the non-patented technology; 6) Inspection and acceptance standards and methods; 7) Utilization fees and methods for paying them; 8) Methods for calculating penalty funds or compensation for losses; 9) The content of technical guidance; 10) Provision and enjoyment of later improvements; 11) Methods for resolving disputes; 12) Explanations of terms and terminology.

Article 75. The technical achievement which is the target of a non-patented technology transfer contract should be a usable and reliable technology which is capable of utilization within the range agreed upon in the contract.

Technical achievements which have not been appraised can be transferred. Technical achievements which must receive appraisal of product and technology utilization on the basis of state regulations can be appraised prior to establishing the contract, and they can be appraised when the contract is established or when it ends. The conclusion of the appraisal should not affect the effectiveness of the contract.

Transfers of phased achievements should assure that repeated experiments can obtain the projected results under specific conditions and specify responsibility for continued development in the contract.

Article 76. When the transferring party in a non-patented technology transfer contract fails to fulfill the contract, they should pay a penalty fund or compensate for losses as stipulated in Article 40 of the Technology Contract Law.

When the transferring party fails to provide the non-patented technical achievements agreed upon in the contract, the recipient party has the right to terminate the contract. The transferring party should return the use fees and pay a penalty fund or compensate for losses.

When a non-patented technical achievement fails to meet technical standards agreed upon in the contract, the transferring party should pay a penalty fund or compensate for losses.

When the transferring party violates secrecy obligations agreed upon in the contract and leaks technical secrets which cause the recipient party to suffer losses, it should pay a penalty fund or compensate for losses.

Article 77. When the recipient party in a non-patented technology transfer contract fails to fulfill the contract, they should pay a penalty fund or compensate for losses as stipulated in Article 41 of the Technology Contract Law.

When the recipient party has not paid the use fees within 2 months, the transferring party has the right to terminate the contract, and the recipient party should pay a use fee and pay a penalty fund or compensate for losses suffered by the transferring party as a result.

When the recipient party violates the secrecy obligations agreed upon in the contract and leaks technical secrets which cause the transferring party to suffer losses, it should pay a penalty fund or compensate for losses.

Article 78. The later improvements mentioned in article 43 of the Technology Contract Law refer to innovations and improvements in a patent technology or non-patented technology made by one or both parties which is the object of the contract during the effective period of the technology contract. A separate contract should be established for reciprocal utilization of technologies which are later improved.

Article 79. After a patent application is submitted and before it is announced, the technology transfer contract between the parties established for the discovery or innovation for which the patent applicaiton is being made should apply the stipulations relevant to non-patented technology transfer contracts. The recipient party should assume responsibility for secrecy obligations and should not obstruct the transferring party from making a patent application.

Prior to the announcement of a patent applicaiton, the original contract should conform to the relevant stipulations for patent implementation permission contracts.

After the patent applicaiton has been approved, the original contract is also a patent implementation permission contract and should apply the relevant stipulations for patent implementation permission contracts.

When a patent application is rejected after it is announced, there should be an announcement that the original contract had ended. When a patent applicaiton is rejected without being announced, the original contract remains in effect.

Section V. Technical Consulting Contracts

Article 80. The parties can establish technical consulting contracts to analyze, discuss, evaluate, forecast, and survey the following types of technical items:

1) Items related research projects in the soft sciences which concern the coordinated development of science and technology with the economy and society;

2) Technical projects which promote scientific and technical progress and modernization of management, and improve economic benefits and social benefits;

3) Other specialized technical items.

However, when one of the parties assigns another party with providing implementation programs to resolve special technical problems, the contract established to implement guidance is a technical service contract, and the stipulations regarding technical consulting contracts do not apply.

Article 81. Technical consulting contracts should include the following clauses:

1) The name of the item; 2) The content, form, and requirements of the consulting; 3) The time period, site, and pattern for fulfillment; 4) Cooperative items of the assigned party; 5) Secrecy for technical information and data; 6) Methods for examination, acceptance, and evaluation; 7) Remuneration and the form in which it is paid; 8) Methods for calculating penalty funds or compensation for losses; 9) Methods for resolving disputes.

Article 82. The parties to a technical consulting contract should completely fulfill the primary obligations stipulated in article 45 of the Technology Contract Law and the various obligations agreed upon in the contract. Excluding other agreements in the contract, the expenses

of the consulting party in carrying out survey research, analysis, debate, testing, and measurement are the responsibility of the consulting party.

Article 83. The consulting party in a technical consulting contract should survey and discuss the technical items. When it is discovered that there are obvious errors and defects in the technical information and data they are entrusted with providing, they should immediately notify the assigned party for supplementation and revision, and assure that the consulting reports and opinions conform to the conditions agreed upon in the contract.

The assigned party should provide the necessary working conditions for the consulting party to conduct surveys and discussion, and they should immediately provide and supplement the information and data.

Article 84. When secrecy is required concerning the technical information and data provided by the assigned party or the consulting reports and opinions provided by the consulting party, the parties can agree upon the scope and time restrictions for secrecy in the contract. When there is no agreement in the contract, the parties have the right to cite and publish, and to provide them to a third party.

Article 85. The consulting party should protect the technical and economic interests of the assigning party. When the consulting party establishes a technical consulting contract for the same type of technical items with a competitor unit of the assigning party, it must obtain the agreement of the assigning party.

Article 86. When the assigning party in a technical consulting contract has failed to pay remuneration on time, they should compensate for the remuneration and pay a penalty fund or compensate for losses. When the assigning party delays in providing the data and information agreed upon in the contract, or when there are serious defects in the data and information that are provided which affect the progress and quality of work, they should pay back in full the remuneration, and they should pay a penalty fee or compensate for losses incurred by the consulting party.

When the assigning party has not provided or has not supplemented the relevant technical information and data and working conditions within 2 months, making it impossible for the consulting party to undertake its work, the consulting party has the right to terminate the contract, and the assigning party should pay a penalty fund or compensate for the losses. This is exclusive of other agreements in the contract.

Article 87. When the consulting party in a technical consulting contract delays in providing the consulting reports and opinions, they should pay a penalty fund. When the consulting reports and opinions do not conform to the conditions agreed upon in the contract, the remuneration received should be reduced or eliminated. When the

consulting party fails to provide the consulting reports and opinions, or when the consulting reports and opinions they provide are of inferior quality and of no value as references, they should not collect remuneration and should pay a penalty fund or compensate for losses.

When the consulting party fails to carry out surveys and discussion within a period of 2 months after the date on which they receive technical information and data provided by the assigning party, the assigning party has the right to terminate the contract. The consulting party should return remuneration already paid and pay a penalty for or compensate for losses. This excludes other agreements in the contract.

Article 88. The parties can agree upon methods for examining and accepting or for evaluating the consulting reports and opinions in a technical consulting contract. When there is no agreement in the contract, appraisal can be organized on the basis of the usual requirements.

Article 89. After the consulting reports and opinions have been inspected and approved as conforming to specifications, the contract should be announced to be ended. The consulting party does not bear responsibility for the decisions made by the assigning party on the basis of the consulting reports and opinions nor for losses incurred in implementation. However, this excludes situations in which the contract contains agreement that the consulting party will make the decisions and guide implementation.

Section VI. Technical Service Contracts

Article 90. The special technical questions mentioned in Article 47 of the Technology Contract Law refer to specialized technical work that requires the applicaiton of scientific and technical knowledge for improving product structures, improving technical processes, improving product quality, reducing product costs, conserving resource and energy consumption, protecting the resource environment, achieving safe operations, improving economic results and social results, and other questions.

Article 91. Processing contracts established which use conventional measures or carry out general processing, fixed work, repair, renovation, advertising, printing, mapping, standardized testing and other measures for the goals of production administration and the survey, design, installation, and construction contracts for construction projects do not belong to the category of technical service contracts.

Article 92. Technical service contracts generally should include the following clauses:

1) The name of the item; 2) The content, pattern, and requirements for the service; 3) Time limits, sites, and patterns for fulfillment; 4) Working conditions and items of cooperation; 5) Standards and patterns for examination and acceptance; 6) Remuneration and patterns for its payment; 7) Methods for calculating penalty funds and compensating for losses; 8) Methods for resolving disputes.

Article 93. The parties to a technical service contract should completely fulfill the primary obligations stipulated in Article 48 of the Technology Contract Law and other obligations agreed upon in the contract. With the exception of other agreements in the contract, the expenditures required by the service party for special technical work and solving technical problems are the responsibility of the service party.

Article 94. When the service party discovers that the technical information and data, samples, materials, or working conditions provided by the assigning party do not conform to the agreements in the contract, they should immediately notify the assigning party, and the assigning party should supplement, revise, and replace them within the time limits agreed upon in the contract.

When the service party discovers that it has not immediately notified the assigning party of the problems described in the preceding clause or when the assigning party has not provided an answer within the specified time period, the responsible party assumes the corresponding responsibility.

Article 95. When the service party discovers during the period of contract fulfillment that continuing with the work poses a risk of damage to the materials, samples, or equipment, etc., they should interrupt their work and immediately notify the assigning party or offer proposals. The assigning party should provide an answer within the specified time period.

When the service party fails to immediately notify the assigning party and fails to adopt suitable measures or when the assigning party fails to provide an answer within the specified time period, the responsible party bears the corresponding responsibility.

Article 96. When secrecy is required for the technical information, data, or samples provided by the assigning party or for the work achievements completed by the service party, the scope and time period of secrecy and the secrecy obligations of each of the parties can be agreed upon in the contract. When the parties violate their secrecy obligations, the responsible party bears the corresponding responsibility.

Article 97. When the object of the technical service contract is discovered to be defective within a short period of time, the parties can agree upon a guarantee period in the contract. When it is discovered during the guarantee period that the quality of the services is defective, the service party should be responsible for repeated work or for adopting measures to compensate. However, this excludes problems due to improper utilization or storage by the assigning party.

Article 98. When the assigning party fails to fulfill a technical service contract, it should pay a penalty fund or compensate for losses as stipulated in Article 49 of the Technology Contract Law.

When the relevant technical information, data, samples, and working conditions agreed upon in the contract and provided by the assigning party affect the quality and progress of work, they should pay remuneration in full. When the assigning party fails to provide the agreed upon material and technical conditions within 2 months, the service party has the right to terminate the contract, and the assigning party should pay a penalty fund or compensate the service party for losses incurred as a result.

When the assigning party fails to pay the remuneration or penalty fund within 2 months, they should return the work achievements, replace the remuneration, and pay a penalty fund or compensate for losses.

When the assigning party delays in receiving the work achievements, they should pay a penalty fund or storage fee. When the assigning party does not receive the work achievement within 6 months, the service party has the right to penalize the work achievement and return the remainder to the assigning party after deducting remuneration, a penalty fund, and storage fee from the income obtained. When the income obtained is insufficient to compensate for the remuneration, penalty fund, and storage fee, they have the right to request that the assigning party compensate for the losses.

Article 99. When the service party in a technical service contract fails to fulfill the contract, it should pay a penalty fund or compensate for losses as stipulated in Clause 2 of Article 49 in the Technology Contract Law.

When the service party delays in turning over the work achievement, it should pay a penalty fund. When the service party fails to turn over the work achievement within 2 months, the assigning party has the right to terminate the contract, and the service party should return the technical information and samples, return any remuneration already paid, and pay a penalty fund or compensate for losses.

When the work achievements and service quality of the service party are defective but the assigning party has agreed to accept them, the service party should reduce the remuneration and adopt measures for appropriate

compensation. When there are serious defects with the work achievements and service quality that have not resolved technical problems agreed upon in the contract, the service party should not receive remuneration and should pay a penalty fund or compensate for losses.

When the samples and technical information provided to the assigning party by the service party are not stored properly and cause destruction, losses, degradation, contamination, or damage they should pay a penalty fund or compensate for losses.

Article 100. Technical training contracts refer to contracts established in which one of the parties assigns another party with providing special project technical guidance and special training for specific specialized technical personnel, but do not include employee training, cultural studies, and employee part time education based on industry or unit plans.

Article 101. Technical training contracts generally should include the following clauses:

1) The name of the item;

2) The content and requirements of the training;

3) Training plans, progress, time limits, sites, and patterns;

4) Qualifications, service records, and levels of teachers;

5) Number and quality of students;

6) Payment and arrangement of food, lodging, communications, and medical expenses for teachers and students;

7) Working conditions and items of cooperation;

8) Remuneration and methods of paying it;

9) Standards and methods for testing;

10) Methods for calculating penalty fees or compensation for losses;

11) Methods for resolving disputes.

Article 102. The primary obligations of the assigning party in technical training contracts are:

1) Assure the quality of students as agreed upon in the contract;

2) Education students observe discipline and heed guidance;

3) Pay remuneration as scheduled.

The primary obligations of the training party in a technical training contract are:

1) Provide teachers meeting specifications as agreed upon in the contract;

2) Formulate and implement training plans;

3) Complete training work according to schedule, assure the quality of training.

Article 103. Technical training requires the necessary sites, facilities, and experimental conditions, and the parties should agree in the contract on responsibilities for providing and managing for relevant sites, facilities, and experimental facilities. When they are not agreed upon in the contract, the assigning party should be responsible for their provision and management.

Article 104. When the training party discovers that the students do not conform to the conditions agreed upon in the contract or when the assigning party discovers that the teachers do not conform to the conditions agreed upon in the contract, they should immediately notify the other party to change the assignments. The party which receives the notification should change the assignments within an agreed upon time period. When there has been no immediate notification or when assignments are not changed as agreed upon, the responsible party has the corresponding responsibility.

Article 105. When the assigning party in a technical training contract does not fulfill the contract, they should assume the following responsibilities:

1) In cases in which the students do not conform to conditions agreed upon in the contract and affect the quality of training, full remuneration should be paid. In cases in which students are not assigned or when assignments are changed to students meeting specifications within 2 months, the training party has the right to terminate the contract, and the assigning party should compensate the training party for the losses it incurs as a result.

2) In cases in which remuneration is not paid as agreed upon in the contract, the remuneration should be paid, and a penalty fund or compensation for losses should be paid.

Article 106. When the training party in a technical training contract does not fulfill the contract, it should assume the following responsibilities:

1) When the instructors provided do not conform to the conditions agreed upon in the contract and affect the quality of training, reduced or no remuneration should be paid. In cases in which instructors are not

provided or assignments are not changed to provide instructors who meet specifications, the assigning party has the right to terminate the contract, and the training party should compensate the assigning party for losses incurred as a result.

2) When training work has not been carried out according to plans and items and causes the results of training not to meet the conditions agreed upon in the contract, they should return all or part of the remuneration and pay a penalty fund or compensate for losses.

Article 107. Technical intermediary contracts are contracts for relationships in which one party establishes a technical contract with a third party on behalf of the other party for knowledge, technology, experience, and information, introduces and organizes industrialized development, and provides services for contract fulfillment.

Article 108. Technical intermediary contracts generally should include the following clauses:

1) Name of the item; 2) Content and requirements of the intermediary; 3) The content of technical services; 4) The time period, site, and pattern of fulfillment; 5) Remuneration and activity fees and methods of paying them; 6) Methods for calculating penalty funds and compensation for losses; 7) Methods for resolving disputes.

Article 109. The parties can independently establish technical intermediary contracts, and they can agree upon intermediary clauses in the technical contract established between the assigning party and a third party.

Independently established technical intermediary contracts are established after the assigning party and the intermediary party sign their names and affix their seals. Contracts which agree upon intermediary clauses are established after the assigning party, third party, and intermediary party sign their names and affix their seals.

The assigning party and intermediary party can come to a written agreement concerning the activity expenses of the intermediary party before the contract is established. When the assigning party and the third party cannot reach agreement on establishing the contract, the assigning party should pay the intermediary party its activity expenses.

Article 110. The primary obligations of the assigning party in a technical intermediary contract are:

1) Strictly provide the requirements for establishing the contract and provide the relevant background materials;

2) Assume responsibilities as agreed upon in the contract for the activity expenses of the intermediary party;

3) Pay remuneration as agreed upon in the contract;

The primary obligations of the intermediary party in a technical intermediary contract are:

1) Authentically describe the ability to fulfill the contract, technical achievements, and creditworthiness of the assigning party and third party;

2) Honestly defend and guard the technical secrets of the assigning party and intermediary party;

3) Provide the agreed upon services for establishment and fulfillment of a contract between the assigning party and intermediary party;

4) Article 111. The activity expenses of the intermediary party refer to expenditures by the intermediary party on relationships and introduction activities for communications, travel, the required survey research and so on prior to establishment of the contract between the assigning party and the third party. The parties can agree to the amount of the activity expenses in the contract. When the parties have not reached agreement, the assigning party should pay the intermediary party the actual activity expenses it has paid.

Remuneration for the intermediary party refers to remuneration that the intermediary party should obtain for transactions between the assigning party and the third party and for services they provide for contract fulfillment. The amount of this remuneration should be agreed upon by the parties.

Article 112. When the assigning party in a technical intermediary contract fails to fulfill the contract, it should assume the following responsibilities:

1) Arbitrary changes of position which cause the intermediary party's labors to be futile or forfeit their reputation should eliminate the effects, restore the reputation, and pay a penalty fund or compensate for losses.

2) In cases where remuneration or activity expenses are not paid within 2 months, the intermediary party has the right to terminate the contract and the assigning party should turn over the remuneration or activity expenses and compensate the intermediary party for losses it incurs as a result.

Article 113. When the intermediary party in a technical intermediary contract fails to fulfill the contract, it should assume the following responsibilities:

1) Concealing the actual situation of a third party and causing losses to the assigning party should pay a penalty fund or compensate for losses. Concealing the actual situation of the assigning party and causing losses to a third party should compensate for losses.

2) For violations of secrecy obligations agreed upon in the contract, they should pay a penalty fund or compensate for losses. When a third party incurs losses as a result, they should compensate the third party for the losses incurred. For utilization of an intermediary party relationship as their own name for unauthorized provision or transfer of the technical achievements of the assigning party or third party, they should pay a penalty fund or compensate for losses.

Article 114. When an intermediary party maliciously collaborates with the assigning party or the third party to damage the interests of the other party, the intermediary party and the assigning party or the third party should assume joint responsibility.

Article 115. With the approval of the assigning party, the intermediary party can change intermediaries, but it should not require the assigning party to pay remuneration or activity expenses to the transferred intermediary party.

Article 116. When citizens establish a technology contract for an intermediary organ to provide services, the intermediary party organ can act as an agent in handling expenditure calculation duties.

Section VII. Arbitration and Litigation of Technology Contract Disputes

Article 117. When a dispute concerning a technology contract occurs, the parties can resolve it through negotiations, and they can request mediation by the relevant departments and organs.

When disputes occur concerning contracts established for scientific and technical items which are included in state plans, the parties can request mediation by authorities in administrative organs at higher levels.

When disputes occur regarding contracts established through an intermediary organ, they can request that the intermediary organ mediate.

When disputes occur among the parties regarding the ownership of technical achievements, they can request that the relevant science and technology commission mediate and deal with it.

The parties should take action to fulfill the mediation agreement document completed through mediation and after resolution.

Article 118. When the parties are unwilling to use negotiation and mediation to resolve disputes concerning technology contracts or when the negotiation and mediation are unsuccessful, one party or both parties can rely on arbitration clauses in the contract or on arbitration agreements reached after the fact to request arbitration by an agreed upon arbitration organ.

The parties can agree to request arbitration by an economic contract arbitration organ, and they can agree to request arbitration by a technical contract arbitration organ.

For disputes which concern patent rights, patent application rights, non-patented technical achievement utilization rights, and transfer rights and for the rights of the party which completes technical achievements, the arbitration organ should assign the relevant science and technology commission or patent management organ to arrive at a conclusion and solve it through arbitration.

Article 119. The arbitration decisions mentioned in article 51 of the Technology Contract Law include arbitration decision documents and the mediation document sent to the parties by the arbitration organ.

When one or both of the parties fails to observe the arbitration decision, they can request that higher authorities or the original arbitration organ reconsider it once. The arbitration decision arrived at in the reconsideration is the final one, and when one of the parties fails to fulfill the arbitration decision within the stipulated time period, the other party can request that the People's Court compel its implementation.

Article 120. When the parties have not established arbitration clauses in the technology contract, and have not reached a written arbitration agreement after the fact, any of the parties can file suit in the People's Court within the time limits stipulated in Article 52 in the Technology Contract Law concerning contract disputes.

Article 121. When the parties or an interested party confirm to industrial and commercial administrative organs that a technology contract is not in effect or that decisions in regard to maintaining a contract in effect are not followed, they can request higher authorities or the original industrial and commercial administrative organs to make a reconsideration. When the conclusions of the reconsideration are not followed, they can file suite with the People's Court within 3 months of the data of receipt of notification.

Article 122. When the parties do not follow the conclusions made by the science and technology commission regarding the ownership of technical achievements, they can ask higher authorities or the science and

technology commission to make a reconsideration. When the conclusions of the reconsideration are not followed, they can file suit with the People's Court within 3 months of the data of receipt of notification.

Section VIII. Management of Technology Contracts

Article 123. The technology contract management organs referred to in Article 8 of the Technology Contract Law refer to science and technology commissions, industrial and commercial administrative organs, and other administrative departments at all levels.

Technology contract management organs should conduct their technology contract management work on the basis of a functional division of labor and in accordance with the stipulations in this article.

Article 124. The State Science and Technology Commission administers the registration of technology contracts for all of China.

Technology contract registration organs in the science and technology commissions of all provinces, autonomous regions, and municipalities directly under the central government are responsible for work to maintain and register technology contracts. Technology contract registration organs can assign the relevant organs to receive the process technology contract registration applications.

Article 125. Technology contract registration organs should evaluate contracts for which registration applications have been made. Contracts which do not conform to regulations in the Technology Contract Law should be registered according to the category of the contract, determine the total amount of technical income, and issue a technology contract registration certificate. For contracts whose primary content includes technology development, technology transfer, technical consulting, and technical services, but which include some transactions of non-patented technologies, the part which belongs to technology contracts should be registered.

Article 126. After a technology contract is established, the parties can make an application for registration to their local technology contract registration organ. When the parties are not in the same region, they can make an application for registration to technology contract registration organs at the locations of the research and development party, the transferring party, the consulting party, and the service party.

Article 127. After a technology contract is maintained and registered, the parties can apply to the relevant specialized bank for a science and technology loan on the basis of the technology contract registration certificate provided by the technology contract registration organ and apply to tax authorities for tax reductions or exemptions. When the parties are units, they can award bonuses to individuals for their

professional technical achievements in completing this item on the basis of the income derived from applying and transferring their professional technical achievement according to the relevant stipulations in Article 6 of the Technology Contract Law and this article.

Article 128. The bonuses mentioned in Article 6 of the Technology Contract Law refer to bonuses provided to the person who completed a technical achievement by units on the basis of income derived from the application of professional technical achievements and through the fulfillment of a technology development contract, technical transfer contract, technical consulting contract, technical service contract according to relevant state regulations.

The expenditures for these bonuses are paid out from profits obtained from implementing technical achievements, the costs, remuneration, or utilization fees derived from the use or transfer of technical achievements, and are not included in the sum of bonuses for the unit and no bonus tax is collected. However, individual income should be taxed according to the law.

Article 129. All provincial, autonomous region, and municipality under the central government People's Governments can integrate with actual conditions in their local regions to determine the amount and proportion for the relevant bonuses.

Article 130. When the parties violate state secrecy regulations and leak important state scientific and technology secrets, the unit in which they work or administrative organs at higher levels should provide administrative disciplinary action. Cases where technology contracts are sold for profit or false contracts are established, science and technology loans are fraudulently obtained or expenditures are used for illegal activities, profit retention, tax evasion or tax fraud, or excessive issuance of bonuses are to receive administrative punishment from, respectively, industrial and commercial administrative organs, financial and taxation organs, audit organs, or administrative organs of higher authorities. In serious cases which constitute crimes, judicial organs should pursue criminal responsibility for the personnel who are directly responsible.

Section IX. Supplementary Articles

Article 131. Technology contracts established before implementation of the Technology Contract Law which continue to be fulfilled after implementation of these articles can apply the regulations in the Technology Contract Law and these articles through written agreement of the parties.

Article 132. The methods for implementing technology contracts which concern national defense shall be formulated in another fashion on the basis of these articles by the National Defense Science and Technology Industry Commission in conjunction with the State Science and Technology Commission.

Article 133. These articles shall be interpreted by the State Science and Technology Commission.

Article 134. These articles are in effect beginning with the date of their promulgation.

China Reiterates Science and Technology Cooperation

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[Local Broadcast News Service]

[Text] In an interview with reporters today, Zhu Lilan, vice minister of the State Science and Technology Commission, said: China will not change its policy of scientific and technological cooperation and exchange with foreign countries. It is hoped that countries and organizations wishing to maintain and develop scientific and technological cooperation and exchanges with China will take a long-term approach to the question of cooperation with China's scientific and technological circles and cherish the relations of cooperation and exchange established over the years.

Zhu Lilan stressed: The policy of reform and opening to the outside world is China's long-term policy. We must continue to uphold and implement it even more successfully. We will continue to seriously implement the scientific and technological cooperation and exchange programs and projects reached with foreign government departments. With the exception of those projects which, because of temporary difficulties encountered due to objective circumstances, have been temporarily postponed through consultation, all other projects will proceed according to plan. We will continue to carry out all types of non-governmental and multilateral international scientific and technological cooperation and academic exchanges. We will do a serious job of receiving foreign scientific and technological experts and scholars who come to China under cooperation programs and help them carry out their tasks. Their safety in China is guaranteed.

Facts and Figures on S&T, R&D Organizations

40081041 Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 4 Jun 89 p 2

[Text] I. The General Situation Nationwide

As of the end of 1988, nationwide, in departments above the county level there were 5,275 publicly owned, independent scientific research and technology development organizations (referred to below as research and development organizations) with staff and workers totaling 1.018 million people; there were 396 publicly owned, independent science and technology information and documentation organizations in departments above the county level (referred to below as S&T information and documentation organizations) with a total of 26,000 staff and workers; there were 2,498 publicly owned, independent county research and development organizations (referred to below as county R&D organizations) with a total of 64,000 staff and workers.

II. Research and Development Organizations

1. R&D Organizations in the Natural Science and Technology Areas.

1) Organizations and Personnel.

Nationwide, there are in all, 4,933 R&D organizations belonging to the natural science and technology fields. Among these, 1,000 R&D organizations are subordinate to the various ministries of the State Council, accounting for 20.3 percent of all R&D organizations in the fields of natural science and technology nationwide.

At the end of 1988, the staff and workers of R&D organizations throughout the country totalled 996,000 people, a 0.16 percent reduction over the previous year. Included were 384,000 scientists and engineers, an increase of 9.3 percent over the previous year and 38.5 percent of all staff and workers. The number of staff and workers in R&D organizations belonging to the various ministries of the State Council reached 575,000. Of this number, 245,000 were scientists and engineers, or 57.5 and 63.9 percent of the national total respectively.

Throughout the nation those R&D organizations implementing the Technological Post Appointment System already totalled 4,260, an increase over the preceding year of 149.3 percent and accounting for 86.4 percent of all R&D organizations. Personnel holding all types of professional technical position (title) number 513,000, a 12.5 percent increase over the previous year and accounting for 51.5 percent of all staff and workers. Among these are 86,000 holding high level technical posts (titles), those holding middle level technical posts (titles) number 212,000 and those holding basic level technical posts (titles) number 215,000. These people account for 16.8, 41.3 and 41.9 percent respectively of all those personnel holding any type of professional technical post (title).

2) Funding.

The total funding and income for 1988 was 13.74 billion yuan, a 22.2 percent increase over the previous year. Included was 6.98 billion yuan allocated by the government, 7.2 percent more than the previous year and 3.72 billion yuan in cross-technology income, a 57.1 percent increase over the previous year. The proportion of total funding and income accounted for by government allocations dropped from the previous year's 58.6 percent to 50.8 percent. The proportion of total funding and income accounted for by cross-technology income increased from the previous year's 21.3 percent to 27.1 percent. Funding and income for the R&D organizations belonging to the various ministries of the State Council totalled 8.99 billion yuan. Of this total, 4.95 billion yuan was government allocated and cross-technology income amounted to 2.57 billion yuan. These account for 65.4, 70.9 and 69.2 percent respectively of nationwide totals.

Overall expense outlays were 12.82 billion yuan, an increase of 23.1 percent over the preceding year. Included were 2.16 billion yuan in labor costs, 24.2 percent higher than the previous year; fixed asset purchase or construction and capital construction expenditures of 3.52 billion yuan, 7.1 percent higher than the previous year. These account respectively for 16.8 and 27.5 percent of total expense outlays. Average labor costs were 2,168 yuan per year per person, an increase of 24.5 percent over the preceding year.

Reform of the allocation system continued to progress. Of 4,933 R&D organizations in the natural science and technical fields, 2,188 organizations reduced operational expenses to varying degrees in 1988. The number of these organizations which were entirely self-supporting in terms of operational expenses reached 821 (including 465 organizations with no operational expenditures while being established) an increase compared with the previous year of 147.

3) The Situation Regarding Research Topics, Papers and Awards.

In 1988, altogether 114,000 topics of all types were pursued, 41,000 were completed and 51,000 scientific papers were published. These papers included 6,647 which were published overseas, representing 12.9 percent of all scientific papers. Scientific and Technological works of 3,097 types and about 468.72 million characters were published.

This year, 10,419 S&T accomplishments received awards of all kinds. These included 596 which received national-level awards and 5,869 which received provincial or departmental awards. These account respectively for 5.7 and 56.3 percent of awarded achievements.

4) The Situation Regarding Integration of Scientific Research with Production.

R&D organizations further strengthened relations with enterprises and economic entities, and relatively good momentum continued to be maintained in the growth of R&D activities into areasof the economy. Nationwide, there are 1,920 R&D organizations with close relationships to enterprises and economic entities. These account for 38.9 percent of all R&D organizations and employ 109,000 personnel of all types or 10.9 percent of the total number of staff and workers in R&D organizations. Organizations which have, through various forms of relationships, entered mid- to large-sized enterprises and enterprise conglomerates total 361. Those organizations which manage or contract to small to mid-sized enterprises number 345. This represents an increase of 39.4 and 89.7 percent respectively over the previous year.

2. R&D Organizations in the Social Sciences and Humanities

Nationwide, there are 342 R&D organizations belonging to the social science and humanities fields. Among these are 46 which are subordinate to the R&D organizations of the various ministries of the State Council. These make up 13.5 percent of all R&D organizations in the social science and humanities fields throughout the country. Within these organizations are staff and workers totaling 21.000 people, including 14,000 scientists and engineers, an increase of 3.1 and 10.5 percent respectively compared with the previous year.

Funding and income for the entire year totalled 194 million yuan, 17.5 percent higher than the preceding year. Government allocations make up 185 million of this amount, 16.8 percent more than the year before and accounting for 95.4 percent of total funding and income. Costs and expenditures amounted to 194 million yuan, a 20.4 percent rise over the preceding year.

During the entire year, 5,896 topics of all types were pursued and 15,000 scientific papers were issued. Of these, 243 or 1.6 percent of the papers issued were issued overseas. Also, 1,209 S&T accomplishments received various kinds of awards.

III. S&T Information and Documentation Organizations

Nationally, there are 396 S&T information and documentation organizations with staff and workers totaling 26,000 people. Included are 13,000 scientists and engineers, representing 50.2 percent of all staff and workers.

Total funding and income for the year was 330 million yuan, including 250 million in government allocations and cross-technology income of 32 million yuan, which account for 75.1 and 9.8 percent respectively of total funding

and income. Within the cross-technology income, income from the S&T information and documentation service was 24 million yuan or 74.7 percent of cross-technology income.

The year's total costs and expenditures were 310 million yuan, including labor costs of 57 million yuan or 18.5 percent of total costs and expenditures.

Over the year, 2.31 million reading sessions were provided, 2.005 million documents of all types were processed, 884,000 data base work sheets of all kinds were created and 2,685 information, investigation and research reports were provided.

IV. County R&D Organizations

Throughout the nation, there are 2,498 county R&D organizations with staff and workers totaling 64,000 people. Included are 7,800 scientists and engineers accounting for 12.3 percent of all personnel.

Costs and expenditures for the entire year were 350 million yuan, a 24.5 percent increase over the previous year.

In comparison with 1987, the number of organizations increased by 137, staff and workers increased by 1,500, and scientists and engineers increased by 2,700.

* Based upon the characteristics of the activities of scientific and technological information and documentation organizations and the classification requirements of the United Nations Educational, Scientific and Cultural Organization. For 1988, scientific and technological information and documentation organizations were separated from R&D organizations, and statistics were calculated independently.

Fault Analysis for Launch-Vehicle Attitude Control Systems

40080186a Shenyang XINXI YU KONGZHI [INFORMATION AND CONTROL] in Chinese Vol 18 No 2, Apr 89 pp 26-30

[Article by Jiang Jie [1203 2638] and Sun Sili [1327 1835 4409] of the Beijing Research and Design Institute of Automation Engineering: "A Fault Analysis Method for Launch-Vehicle Attitude Control Systems"; manuscript received 15 Aug 88; received the 1988 award from the China Automation Society for outstanding scholarly paper written by a young person]

[Excerpts] Abstract: This paper reports on research that proposes a fault analysis method for launch-vehicle attitude control systems that is called the "Fault-Function Analysis Method" (F-FAM). F-FAM is composed of two parts: the fault-function tree analysis and the fault pattern analysis, the latter being an extension of the former. In analyzing fault patterns, this paper emphasizes addressing the fault model parameter assessment problem for each link in the attitude-control system. Finally, it uses actual examples to explain the effectiveness and quickness of this method when used for attitude-control-system fault analysis.

Key words: attitude control systems, fault diagnosis, parameter assessment

1. Introduction

We know that the structure of a launch-vehicle control system is quite complex and that the faults that will appear are of different kinds, which creates difficulties for the analysis of faults. Often in the past, faults were analyzed with the "fault recurrence" method, but generally speaking this method is quite troublesome, and there are also faults of this type (as for example with multiple faults) that make analysis very difficult. This research has proposed a fault-analysis method for launch-vehicle attitude control systems--the fault-function analysis method, the characteristics of which are: in accordance with the results of launch-vehicle flight tests and telemetry data, we began with actual occurrences of attitude-control-system faults and went gradually deeper into the system to look for faults at each link until we had diagnosed those faults. We guaranteed the accuracy of the fault diagnosis and improved the speed, so that it now can not only analyze single faults in the attitude-control system, but can also analyze and diagnose multiple faults, as well as assessing the pattern parameters at each link after system faults.

F-FAM is composed of two parts: one is the fault function tree analysis, and the other is the fault pattern analysis. In accordance with the requirements of the particular system for levels of fault diagnosis, the fault-function tree analysis separates the system into components (or subsystems) and treats each component (or subsystem) as an entire system having a particular function and the loss of this function as the basic fault event. It also treats the discovered system fault as the head event in constructing a fault-function tree (F-FT), then analyzes the F-FT to find all fault patterns causing faults in the system; fault pattern analysis is a further elaboration of the F-FT, and it analyzes the fault patterns just described to determine which fault patterns cause system faults, which satisfies the task of fault diagnosis. This paper also proposed a fault pattern parameter assessment method for the fault schema analysis of the pattern parameter jumpiness of components (or subsystems), which effectively settles the analysis of pattern parameter jumpiness fault schema.

To meet the demands of rapid diagnostic techniques, this paper treats function faults of subsystems (links) that the system need not further resolve as the basic fault events of F-FT. In this way, it greatly reduces the amount of work in building the tree and improves the speed at which that is done. It is the fault schema analysis proposed by this paper that enables this determination of fundamental fault events, and not only can it determine which fault schema led to system faults, but it can also diagnose the particular places where faults occur.

2. Fault-Function Tree Analysis

2.1 The Definition of F-FT

The F-FT is a special tree-shaped chart of logical causality relations. It uses artificially constructed event designators, logic gates, and jump indicators of various sorts to describe the causal relations among various events in the system. Events input to logic gates are the "causes" for output events, and the output events from logic gates are the "results" of input events.

2.2 The General Method for Constructing F-FTs

Tree construction is done by deduction in this paper. A system fault event that has been analyzed is first written out as the first section (i.e., the first line, which is called the "head event"), then the direct reasons leading to the occurrence of the event (including hardware faults, software faults, environmental factors, and artificial factors) are listed as the second section, represented with the appropriate event designators, and then the appropriate logic gates are used to connect them with the head event. Then, the direct reasons leading to all faults in the second section are separately listed below each event of the second section; this makes up the third section. Appropriate event designators are used to express this, then the correct logic gates are used to connect these with the events corresponding to the second section. This process is continued until all the basic factors (basic fault events, also called "base events") are analyzed. A logic chart drawn in this way is called an F-FT.

2.3 Fault-Function Tree Analysis

Fault-function tree analysis is the writing out of the structural parameters for the head events in an already-constructed F-FT, where the structural parameters are the Boolean parameters for the head-event status. This is the mathematical description of the F-FT; in finding all the smallest cut-sets of the F-FT (by "minimum cut-set" is meant the smallest set of basic fault events that can stimulate F-FT head events, and which indicates the combining mode for causes of head events), each minimum cut-set indicates a fault schema, by which process can be found all fault schema occurring as head events (system faults).

In the end, which fault schema have occurred, stimulating system faults, can only be determined through fault schema analysis.

3. Fault Schema Analysis

3.1 An Assessment Method for Fault Pattern Parameters

The fault pattern parameter assessment method solves the fault pattern parameter assessment problems for launch-vehicle attitude control systems when those problems are successive or discrete links. This algorithm was implemented on a VAX-11 780.

The fault pattern assessment method is composed of two parts: 1) A discrete pattern parameters assessment. To comply with the characteristics and demands of fault pattern parameters assessment of each link in the launch-vehicle attitude control system, this research introduced to the discrete pattern parameters assessment method a maximum likelihood method with a wider ranging scope of suitability, which has been improved (and is called the "improved maximum likelihood method"). The improved maximum likelihood method is used to identify the discrete time fault pattern parameters of each link according to observed data input and output to and from each link after the launch-vehicle flight faults. 2) The discrete pattern parameters are converted to equivalent successive pattern parameters. If the links that are analyzed are successive links, then this conversion proceeds.

3.1.1 The improved maximum likelihood method

[Passage omitted]

3.2 Fault Schema Analysis

After fault-function tree analysis, the result is a schematic (minimum cut-set) of all faults in the fault-function tree. Fault schema analysis is based on fault-function tree analysis, where each fault schema is analyzed to determine which fault schema phenomenon led to a system fault, which thus accomplishes the task of fault diagnosis. For the purposes of discussion, this research has proceeded from an analytical design of attitude-control systems, analyzing fault schema according to two large categories: one is a hard-loss damaging fault, and the other includes those fault schema that have jumpy pattern parameters.

By hard-loss damaging fault schema is meant such component (or subsystem) damaging fault schema as output fractures, mechanical card failures, and power-supply failures. The analysis of these fault schema can be accomplished by telemetry signals from both ends of the component (or subsystem) and relies upon the experience of the analyst. The analysis of pattern parameter jumpy fault schema is through analysis of observed data from both ends of the component (or subsystem), where the pattern parameters are identified through the fault pattern parameter assessment method. This is compared with pattern parameters at the design (normal) time to determine whether this component (or subsystem) has experienced a failure. This resolves the problem of fault detection, and distinguishes faults according to relations between system pattern parameters and particular system coefficients.

4. Real F-FAM Application Examples

As real examples of F-FAM applications, the authors have used this method to analyze three simulated fault events in which a certain launch vehicle's "attitude control system diverges, causing a loss of stability in flight": 1) a rate gyro unit passage wire-break fault event in the launch-vehicle attitude control system pitch channel; 2) two fault events in this launch-vehicle attitude control system: the pitch-channel control feedback turned off and there were changes in pattern parameters for the correcting network; 3) three fault events in the launch-vehicle control system: the pitch-channel control feedback turned off, and pattern parameters changed for the correcting network and the rate gyro. The causes and locations were quickly diagnosed, and the pattern parameters of each link after the system fault were identified, which shows that F-FAM is feasible, and also that it is a rapid fault diagnostic method.

5. Conclusions

Research reported on in this paper proposed F-FAM, which on the basis of a diagnosis of faults by a fault tree analysis method and system identification method, is an effective, feasible fault-analysis method intended for the characteristics and actual conditions of fault diagnosis for launch-vehicle attitude control systems. It improves the accuracy and speed of fault diagnosis, and solves the problems of diagnosing the pattern parameter assessment of each link after multiple faults and system faults. F-FAM is a general method of fault analysis, and it can also be used for fault analysis of automatic control systems in other fields.

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Ministry of Machine-Building and Electronics Industry's No. 14 Research Institute

40080188a Beijing ZHONGGUO DIANZI BAO in Chinese 9 May 89 p 3

[Article by Jing Deji [4842 1795 1015]; see also JPRS-CST-89-011, 24 May 89 pp 143-145]

[Text] The problem of how to carry out technological and economic reforms at research organizations is a topic of great concern to many research institute directors. In a recent interview at the No. 14 Research Institute of the Ministry of Machine-Building and Electronics Industry [MMEI], this reporter had the opportunity to learn the difficult problems facing the research institutes.

New Flowers Growing on an Old Tree

The No. 14 Research Institute of MMEI is one of the first electronics research institutes established in this country. Currently, it has over 5,000 personnel including more than 2,000 engineers and over 500 senior engineers. During its 40-year history, it has developed more than 1,300 scientific products, 200 of which are considered to be state-of-the-art accomplishments. Specifically, it has developed high-technology products for national defense and integrated electronic systems; it has also made important contributions to many of China's major projects such as launching of artificial satellites and missiles, nuclear tests, and development of China's defense systems and of a tracking system for "Sky Lab."

However, as a result of the sharp reduction in military production since the early 1980's, the Institute faced the problem of finding work for several thousand employees. Instead of waiting for things to happen, the Institute decided to take the initiative by devoting part of its resources to developing commercial products. These products include commercial radars used for air and ship traffic control, channel survey and weather forecast; communications and television equipment and industrial automation equipment; medical and sports electronics equipment; special-purpose test equipment; microwave ferrite devices and

soft magnetic materials; and integrated thick-film and thin-film circuits. However, because of the Institute's history of developing only single electronic units or systems, it had encountered numerous technical problems in this new environment and its production efficiency dropped sharply. The only way to overcome these difficulties is to initiate reforms of the Institute.

Major Re-organization of the Institute

One year ago, in early 1988, the Institute initiated a series of reforms including delegation of authority, technology subcontracting, and target management. In particular, it insisted on the separation of Party and administrative functions by giving the central authority to the Director of the Institute and assigning the Party officer to a monitoring position; the director would have the authority to make decisions on management and production issues, and the hiring and firing of personnel. The number of Party representatives at the Institute was reduced by 36 percent. Everyone at the Institute was assigned specific responsibilities under the leadership of the Director working for the common goal of research and production.

Since the second half of 1987, the Institute was re-organized into two major divisions: the military products division and the commercial products division. The original theoretical research office became the preliminary research office, which includes a laboratory that provides support to other offices; it maintains the facilities of basic research and applied research for military products. Later, a ground electronics equipment department and an aviation electronics equipment department were established to develop high-technology electronic equipment for the future. In the commercial products area, an electronic systems department was established to develop commercial radars, ground systems for satellite broadcasting and communications, microwave data communications equipment, electromechanically integrated equipment, equipment for transforming traditional industrial technology, and microwave components. In addition, special offices were also established in the areas of ferrite research, environmental protection weak-current research, and microelectronics research to support the development of secondary products and to facilitate the conversion from military to commercial production. The original workshops were reorganized into five special-purpose production factories under separate management. It has also established lateral business links with local industries in Jiangsu and Zhejiang Provinces and entered into various joint ventures with companies in the special economic zones and in foreign countries to develop electronic products and high technologies.

Subcontracting Approach Pays Off

As part of the 1988 subcontracting-responsibility system, the Institute established five different award categories which clearly define the

responsibility, privilege, and profit associated with each category. The subcontracting approach specifies a fixed number of personnel, fixed cost and fixed expenditure on a project, and guarantees its schedule, quality and safety. Under this arrangement, the man-year cost is 4 000 yuan for each scientist or engineer and 3,000 yuan for each factory worker. In addition, in the administration, finance, instrumentation, and materials departments, internal rules and regulations were established to comply with the overall subcontracting policy. After one year of operation under the new organization, the annual production has increased 42.4 percent, earnings nave increased 24.6 percent, and the average income of Institute personnel has increased 25.36 percent.

Remaining Problems

Inspite of the encouraging results of the initial reforms, numerous problems still remain. According to a deputy director of the Institute, "The internal reforms have not proceeded uniformly, and conversion from the old organization is incomplete. The lateral subcontracting relationships have not been clearly established, and there are still weak links in the macro-management structure. Although the Institute has overall goals and policies, detailed plans and practical procedures are lacking. This year, we are facing considerable difficulties in meeting the demands of an increasing number of research tasks due to the severe shortage of funds and electric power, and the high cost of raw materials."

Long March-2E Still Favorite in Launch Service Competition

40080199 Beijing HANGTIAN [SPACEFLIGHT] in Chinese No 3, 26 May 89 pp 4-5

[Article by Zhu Weizeng [2612 4850 1073]]

[Text] Since the first launch of the manned space shuttle developed by the U.S. National Aeronautics and Space Administration, a new strategy for launching geosynchronous satellites has been introduced. With this strategy, the satellite is first injected into a low-earth orbit, and then placed in a geosynchronous transfer orbit by a perigee transfer maneuver. After lift-off, the space shuttle first carries the satellite, which is equipped with a perigee motor (also called the upper stage) into a low-earth parking orbit; once it attains the correct attitude, the satellite and the perigee motor are ejected out of the cargo bay of the space shuttle. Then, the perigee motor is activated and propels the satellite into a geosynchronous transfer orbit. The perigee of the transfer orbit is the same as that of the parking orbit, i.e., approximately 200 km; the apogee is approximately 35,800 km. When the satellite reaches the apogee, the apogee motor is activated, and sends the satellite into the desired geosynchronous orbit.

A communications satellite equipped with an upper stage has a great deal of flexibility in choosing its launch vehicle. The upper stage is not the third stage of the launch vehicle but part of the satellite; it can be launched either by a space shuttle or by an expendable launch vehicle. The launch vehicle need only have two stages because it is only required to send the payload (the satellite and the upper-stage) into a low-earth parking orbit.

In early 1986, the U.S. space shuttle "Challenger" was destroyed in an accident. In an effort to determine the cause of the accident and to improve the design, the U.S. Government spent more than 2 years. The Reagan Administration decided not to use the space shuttle for launching commercial satellites, but only for launching important military satellites and scientific research satellites. This severe set-back caused some of the commercial satellites originally scheduled to be launched by the space shuttle to turn to unmanned expendable

launch vehicles. The European Consortium headed by France, the Ariane Space Corporation, took advantage of this situation and acquired 1/3 of the commercial launch market; approximately 40 commercial satellites have already signed contracts with Ariane. The United States has also resumed production of its expendable launch vehicles to supplement its launch capability. For example, the Titan-III, the Delta-II and the Atlas-Centaur rockets have received contracts for 14 commercial launches. The Titan-III and the Delta-II rockets will adopt the same launch strategy as the space shuttle, i.e., initial injection into a low-earth parking orbit followed by a perigee orbit transfer.

The demand for an expendable launch vehicle is primarily determined by its payload capability. Since the 1970's, approximately 100 commercial communications satellites have been launched. These early satellites weighed between 1 ton and 1.4 tons, and had 12 transponders. Some of these satellites are approaching the end of their design lives; some are entering their middle years. According to authoritative predictions, due to the increasing demand on communication capacity, the development of new technologies, and the limited orbital positions the 1990's, heavy satellites with large capacity, high power, long design life and low cost will play a major role in the communications satellite market. It is estimated that 80-90 satellites will be deployed; they will generally weigh between 2.5 tons and 3.2 tons, have 50 transponders, and have design lives of 10-12 years.

In order to meet the demands of the international launch service after 1990, Japan began developing the H-2 launch vehicle several years ago; it is expected to be operational by 1992. Its payload capability for geosynchronous transfer orbit will be 4 tons. After 1989, the U.S. Titan-III rocket, the Atlas-Centaur rocket, and the Delta-II rocket will also become operational.

Aerospace technology is generally regarded as one of today's high technology areas; its development requires a large amount of investment, involves a high degree of risk, but has a high potential payoff. The governments of the United States, the Soviet Union, France and Japan have all established protectionist policies in developing space-related trade. For example, in 1987, 3 satellite launches by the French Ariane rocket produced a profit of more than 50 million dollars.

China has more than 30 years experience in rocket development; our technical resources, low production cost and high product quality will put us in a highly competitive position. There is no reason why we cannot obtain a share of the satellite launch market.

However, to compete in this market after 1990, we must have the capability to launch a payload of more than 2.5 tons into a geosynchronous transfer orbit. China's Long March-3 launch vehicle has successfully launched four of China's experimental and operational communications satellites into geosynchronous orbits. The Long March-3

is a highly reliable rocket which can provide launch service to the outside world, but its payload capability for geosynchronous transfer orbit is only 1.4 tons, which is inadequate to meet the primary demand of the 1990's.

The Long March-3 was developed based on the Long March-2 liquid-propellant two-stage rocket. The Long March-2 has had a higher launch success rate--it has launched 11 of China's retrievable scientific satellites into low-earth orbits.

Clearly a direct approach to increase the launch payload capability, reduce launch cost, and maintain high reliability is to take advantage of the highly mature Long March-2 rocket technology and augment it with 4 liquid-propellant boosters. By enlarging the propellant tank of the first and second stages by 10 m and strapping 4 liquid-propellant boosters to it, one can increase the parking-orbit launch capability from 2.5 tons to 8-9 tons. This increased capability allows the user to deploy higher payload weight for the satellite and the perigee motor. The mass ratio between the satellite and the perigee motor is approximately 1:2. For a more advanced perigee motor, this ratio may be reduced to 1:1.5.

The Long March-2 with strapped-on boosters is called the Long March-2E. Its development began in 1986. It has already passed the stages of conceptual design, preliminary design and structural design; now it is in the production stage. The first flight test is scheduled to be between March and June of 1990. In early 1991 and mid 1992, it will launch two second-generation Australian satellites (AUSSAT-B); the satellites will be built by the Hughes Corporation, and the perigee motors will also be procured by Hughes.

The development of the Long March-2E is based on the following two ground rules: its performance must meet the international launch service standards; and its technical configuration is determined by domestic users. A schematic diagram of the Long March-2E is shown in the attached figure.

The lift-off weight of the Long March-2E is 462 tons, and its lift-off thrust is 600 tons. Its overall length is 51 m. It is propelled by a two-stage core rocket engine augmented by 4 liquid-propellant boosters. The core stage has a diameter of 3.35 m, and each booster has a diameter of 2.25 m.

With the exception of the four booster engines, the propulsion system of the Long March-2E is identical to that of the Long March-2. The added booster engines are the same as the first-stage core engine.

The control system of the Long March-2E is also identical to that of the Long March-2. However, at the request of foreign customers, two new systems have been added: the payload spin-up system and the payload attitude control system.

The function of the payload spin-up system is to impart an initial rotational speed to the payload about the longitudinal axis prior to payload separation from the launch vehicle (if the payload is three-axis stabilized, then no spin-up is required). There are two ways to spin up the payload: one is to use a small solid rocket to spin up the second stage; the other is to use a spin-up platform.

The payload attitude control system has been flight-tested on the Long March-3 launch vehicle.

The structural system of the Long March-2E launch vehicle includes the propellant tank, the inter-stage segment, the instrument compartment, and the payload cowling. Most of the materials and equipment of the structural system are adopted from the Long March-2 or Long March-3 rockets. The only component that requires new development is the payload cowling.

The payload cowling has a split shell structure 12 m in height and 4.2 m in diameter; the shell is made of metallic and non-metallic honey-comb construction. The cowling is discarded when the second stage reaches an altitude of 120 km. The separation device consists of a non-contaminating explosive cable and a "sheath" mechanism to ensure that the payload will not be contaminated or subject to excessive impact load during separation. The payload cowling and the payload are assembled in the Technical Center at the Launch Site; then it is transported in a vertical position to the Launch Center, where it is lifted onto the second stage. The payload and cowling assembly is connected to an air-conditioning system which maintains its temperature between 15℃ and 25℃, and its humidity below 55 percent.

The Long March-2E will soon become available to provide reliable, low-cost launch service for the international satellite launch market; let us wish it great success.

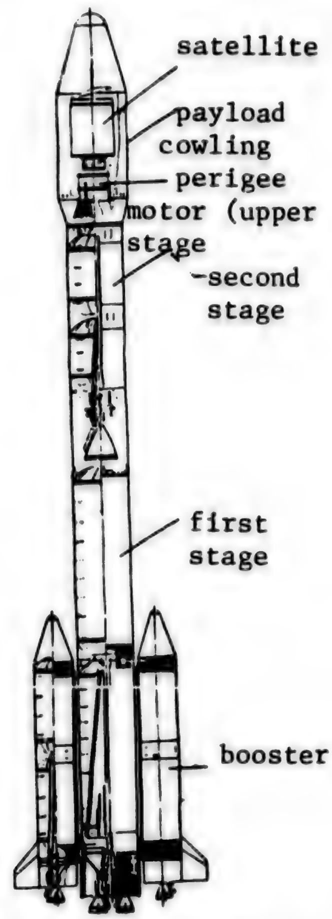

Figure 1: Components of the Long March-2E

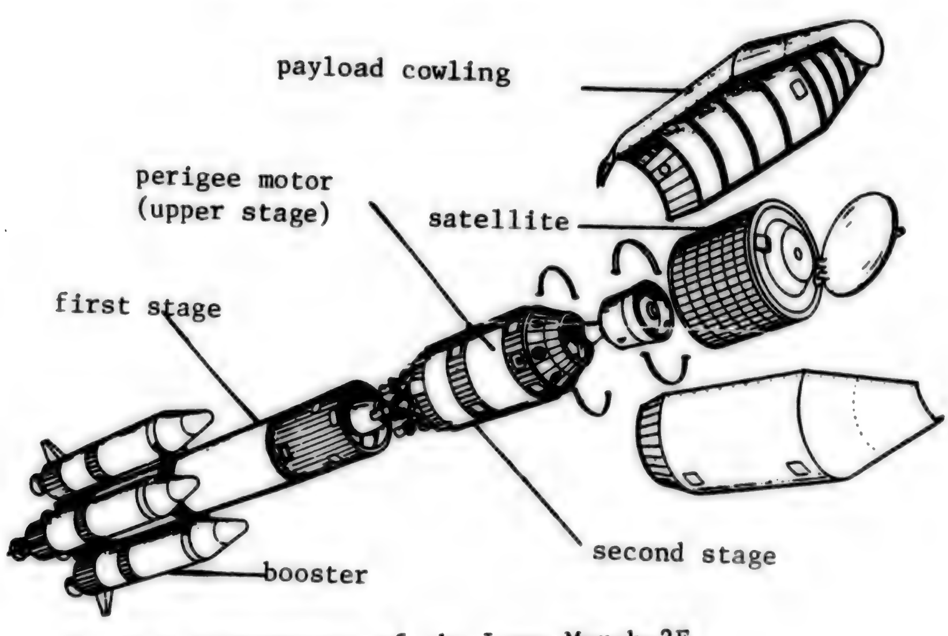

Figure 2. Payload Compartment of the Long March-2E

Activities of China Flight Test Research Center Reviewed

40080207 Beijing GUOJI HANGKONG [INTERNATIONAL AVIATION] in Chinese No 6, Jun 89 pp 7-8

[Article by Ge Ping [2047 1627] and Yan Jinglin [0917 0079 2651]]

[Text] In the heartland along the Yellow River, north of the Wei River, there is an aeronautical industrial base not commonly known to the outside world until China initiated its open-door policy in the 1970's. This is the so-called "Aircraft City" located in the northern outskirts of Xi'an. The China Flight Test Research Center is a key segment of this city.

Established in April 1959, the CFTRC's main mission is to conduct national certification flight tests and research flight tests of new equipment developed by the aviation industry. It is China's only flight test facility for aircraft, engines, and airborne equipment. Over the past 30 years, it has completed national certification tests on more than 10 different types of aircraft and aeroengines, and certification tests of several hundred systems and products in the areas of avionics, special-purpose instrumentation, high-altitude escape, and fire control; it has also completed over 2,000 research projects. As of 1987, the CFTRC had received 3 national invention awards, 30 other awards from the state, 97 awards from the Ministry of Aeronautics and Astronautics Industry, and 6 awards from Shanxi Province. In recent years, it has completed certification flight tests on three new aircraft.

After 30 years of steady development, this piece of once-desolate land has become a transportation and communications center of the Northwest visited frequently by foreign officials and businessmen.

Overview

The flight test center has nearly 2,000 technical personnel (including approximately 300 senior engineers); it also has a team of well-trained, experienced, and highly motivated test pilots. Flight test heroes such as Wang Ang, Hua Jun and Huang Bingxin are outstanding representatives of this team.

The flight test center owns dozens of test aircraft which include various types of Chinese-built aircraft. There are more than 10 research departments specialized in many technical areas including aircraft, helicopters, flight simulation, automatic control and navigation, model free-flight, material strength, engines, propulsion systems, electronic equipment, fire control instruments, and high-altitude protection and escape. The research personnel of the test facility are responsible for the operation of the airborne and ground instruments and equipment and for data processing. They are also involved in the development of special-purpose equipment, test instruments and sensors for the flight test center. An office of measurements ensures accurate exchange of the measured data between different segments of the test programs. The two 3,400-meter runways are equipped with navigation instruments designed for both day and night operations. The flight test operation and aircraft maintenance are performed by personnel on the base; any modifications or conversions of the test aircraft are done at the affiliated conversion factory.

Development of Experimental Techniques

The Chinese flight test team basically had evolved with China's young aviation industry. In order to establish a technical capability to provide full support for flight test activities, the flight test center had insisted on a policy of conducting research both in flight test methodology and on certain specialized topics. Today, it not only has the capability of conducting flight tests of new aircraft, improved and converted aircraft and various flight systems, it has also made significant progress in advanced experimental techniques and theoretical methods. For example, major accomplishments have been made in applying parameter identification techniques to determine aerodynamic coefficients of aircraft and applying Kalman filter techniques to determine the aerodynamic coefficients of helicopters; new techniques for flutter experiment, vibration measurement and dynamic test have already been used in certification and research flight tests; research has been conducted on measuring structural deformation and monitoring fatigue of aircraft in flight; also, research has been completed on the use of interior measurement technique, fixed-target technique and swinging-target technique to facilitate actual measurement of engine thrust, tension and airplane polar curves. In addition, experimental research has been carried out in the areas of mid-air engine starting and engine stability; in the area of engine environment, experimental techniques have been developed to study ice formation, bird expulsion, smoke injestion and forced breathing, etc.; in-flight measurement techniques have also been developed to monitor the vibration, temperature, and strain of rotating engine parts; in the area of life preservation systems, combined activities of engineering research and physiological research are being carried out; in flight test planning, system engineering approaches have been used to improve the economic benefits through coordinated management.

The development of flight experimental techniques plays an important role in resolving key technical issues and in supporting preliminary design. By collecting large amount of flight test data, the CFTRC has laid a solid

foundation for establishing technical specifications for aircraft design; for example, in establishing flight quality specification, flight performance specification, material strength specification, vibration specification, engine test specification, specification of static standards of instrumentation, and a series of flight test standards, the center has provided a large amount of valuable flight test data. It has also completed flight tests under weightless conditions to support the development of aerospace science.

Development of Experimental Equipment

The development of flight experimental technique is closely related to the development of experimental equipment and test procedures. The in-flight engine test stand is a large test platform designed to perform engine tests during flight; it is frequently used in testing and tuning new engines, in high-risk flight tests, and in research and development of specialized equipment. The special electronic test unit which was converted from the imported "Citation-II," has an integrated aerial survey system with an inertial guidance and control unit and a radio-navigation calibration device; it can be used to calibrate various navigation and electronic equipment and perform aerial survey missions. The Chinese-designed ejection and escape mechanism can be used to perform ejection tests not only in flight but also on a ground vehicle moving at low velocity. The newly-developed high-velocity ejection mechanism and the variable-stability aircraft will soon become operational.

The ground test facilities include the flight simulator, the flight control system test platform, the underground engine test stand and the open-air test stand, the engine fuel/oil regulating system test unit, the thrust measurement platform, the ejection test stand, the high-altitude test chamber, the high-voltage and static-electricity laboratory, and the antenna range. These test facilities play a very important role in certification flight tests, in preliminary research and development, and in improving flight test procedures and efficiency.

During the early days of CFTRC, airborne equipment must rely on automatic recorders and optical oscilloscopes. In the mid-1960's, a first-generation frequency-modulated digital magnetic recording system was developed; it was later integrated with a Chinese-built radio telemetry system to provide real-time monitoring capability for a limited number of parameters. At the end of the 1970's, a second-generation digital recording system was developed, and a French data collection system and data processing station were imported. In the early 1980's, the flight test center imported a state-of-the art real-time data processing system which greatly enhanced the efficiency of research and development; in particular, it provided a means for measuring velocity parameters which have strict time correlation requirements such as the cross-sectional pressure distribution in the engine inlet. By the

mid-1980's, a computer-based system was implemented to provide enhanced capability for processing flight test data. The use of these modern test equipment and measurement systems not only enhanced the efficiency of flight tests by collecting multiple test data during a single flight, but also improved its quality and safety through continuous command and monitoring. In addition, they also provided favorable conditions for implementing innovative management techniques and reforms in the CFTRC organization.

Promoting Diversification and Developing Commercial Business

During the 10 years of reform, the flight test center has followed the development trend of the aviation industry and established a research office to study the flight worthiness of commercial airplanes. After completing the flight tests of the Chinese-built Y-8 aircraft, a full-scale, in-depth research program on flight test methodology and measurement techniques was initiated for studying the air-worthiness of commercial aircraft. With the growing commercial aircraft industry in China, it is believed that the flight test of commercial aircraft will become one of CFTRC's prime missions.

In addition to the activities of flight tests and ground tests of airplanes, engines and onboard equipment, the center also provides the services of telemetry, remote-sensing and aerial photography for the departments of energy, transportation, urban development, geology, agriculture and forestry, and state planning. In the past, it has accepted requests for developing automatic monitoring systems, sensors, converters, and data recording systems, it has carried out the design, development, performance measurement and flight test of antennas. It has also accepted assignments to conduct research and development in the areas of material strength, vibration and noise monitoring and suppression for onboard equipment, to design, process and produce non-standard equipment for various systems, and to repair, inspect and install various motorized equipment. In addition, the flight test center has made significant efforts toward developing commercial products and products for foreign export. Currently, the flight test center is undergoing administrative reform to accommodate the changing environment of the industry.

Promoting International Cooperation

In recent years, the flight test center has significantly expanded its cooperative ventures with other countries. Since the start of the open-door policy, the center has imported a variety of state-of-the-art equipment; it has also sponsored over 200 students, trainees, scholars engineers to travel abroad for training, study, visit and technical exchange. Over the past decade, the flight test center had hosted more than 30 delegates from Great Britain, the United States, France, West Germany, Sweden, and Pakistan, as well as several hundred individual visitors; it had also participated in cooperative research activities with aerospace research institutions of West Germany and Sweden, and made significant contributions in the area of flight mechanics and aerodynamics research.

Meeting the Challenges of the Future

In view of the changing scenario of the aviation industry, the personnel of the flight test center fully understand the challenges they are facing. By the year 2000, there will be significant breakthroughs in China's new aircraft development; the new aircraft will incorporate an increasing number of new technologies and new systems, which in turn will place heavier loads on research flight test requirements. Specifically, this implies the following:

1. The number of parameters to be measured during flight test will greatly increase. It is estimated that in the 1960's, the number of parameters measured on a military aircraft was approximately 200, by the end of the 1980's, this number will increase to 1,000; on a commercial aircraft, the number will increase from 300 to approximately 3,000.

2. The number of flight test hours will significantly increase. In the 1960's, approximately 700-1,000 hours were required to flight-test a new aircraft; by the end of the 1980's, this will increase to 3,000 hours. If there are delays or mistakes during flight tests, the new aircraft may well lose its competitive opportunity because it no longer has the state-of-the-art advantage.

3. The cost of flight test will rise considerably. For example, the average cost of measuring one parameter on a foreign military aircraft today is as high as $US4,400.

4. The safety problem will become a major issue. This is a natural consequence of using a large number of new technologies and introducing an increasing number of unknown factors.

Faced with this new scenario, the flight test center is closely watching the development trend of advanced nations with the intention of absorbing their new technologies and experience. At the same time, it has taken various measures toward further developing flight test procedures, increasing flight test efficiency and reducing cost. These measures include enhancing the ground simulation capability, developing various new equipment for test and research, developing new measurement techniques and application software, utilizing telemetry, remote-sensing and spatial positioning techniques, enhancing real-time monitoring capability, increasing data processing efficiency, improving flight test organization and management, and establishing quality assurance and safety systems. As a member of China's aviation industry, the CFTRC is ready to meet the challenges of the revolution currently taking place in modern aviation technology.

VAX Finite-Element-Analysis Graphics Plotting Software Announced

40080175a Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 16, 26 Apr 80 p 2

[Article by Yan Junlong [0917 7486 7893]: "Three Graphics Systems with VAX Finite-Element Analysis Programs and Data Processing Software"]

[Text] The Northwest Academy of Prospecting Design of the Ministry of Energy Resources has announced three graphics systems with finite-element analysis programs, which are:

1. DSAP5--a post-processor for the SAP5 structural analysis program.

On VT240 terminals or on several different plotters, this software can plot spatial finite-element-analysis grid graphs, grid blanking graphs, and displacement graphs. It can also use spatial arbitrary directional planes to cut across spatial finite--element grids, can arrange and plot the vectors and data graphs for displacement, principle stress, normal stress, and shearing stress within the cut cross-section, as well as contour graphs of principle stress, normal stress, and shearing stress.

2. DNOLM83--a post-processor for the NOLM83 rock-and-soil-system planar non-linear analysis program.

This program can plot the vectors and data graphs on different kinds of plotters for finite-element graphs, node displacement, principle stress, normal stress, and shearing stress, as well as their contour graphs. It can also follow linear shear sections and map plastic failure-region range charts.

3. RCNP1C--a post-processor for the RCNL01 mass concrete non-linear analysis program.

This software can plot out on different kinds of plotters vector and data graphs of finite-element grids, node displacement, primary stress, normal stress, and shearing stress, as well as their contour graphs. In addition, it can also plot tracking graphs for plastic regional concrete cracking.

The three graphics systems just described were written in VAX FORTRAN. For the convenience of the user, are all invoked interactively, so the user need not remember all commands, but can follow menu prompts to use the functions.

The data processing software NEWEDIT was written in Pascal, and provides the VAX series of computers with a "list" editor. It makes use of the regularity of coordinate values and node numbers in finite-element data so that by only entering a few control codes the finite-element original data can be automatically generated. It also has such functions as line-by-line crosses, column-by-column projections, character scanning, insertion of character strings, deletion of character strings, truncation of files, concatenation of files, and the changing of characters, and a special function is its search function for various topological problems in one, two, and three dimensions.

This software has undergone 1-3 years of operation and testing, and has been used to plot more than 3,000 result graphs for such hydroelectric stations as Longyang Xia, Lijia Xia, Laxiwa, Baozhusi, and Qingtongxia, from which has been gained clear economic results.

Signal-Analysis, Fault-Analysis Devices Announced

40080175b Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 16, 26 Apr 89 p 2

[Article by Xiong Wen [3574 2429]: "Two Microprocessor Products from Baoying Plant Successful in International Bidding"]

[Text] The MT-401 signal analyzer and the 200 intelligent machine fault analyzer developed and manufactured by the Jiangsu Baoying Vibration Instruments Plant were recently successful in international bidding for a World Bank loan. This signifies that China's medium-to-high-level intelligent instruments have attained a significant degree of development, manufacturability, and competitiveness as they begin to appear in world markets.

The MT-401 signal analyzer is a microprocessor device especially for vibration signal processing. It has such functions as data acquisition, A/D conversion, data processing, and screen dump, and it does such complex operations as amplitude spectra, power spectra, scrambled frequency spectra, correlation, coherence, probability calculations, Nyquist graphs, transfer functions, and direct FFTs [fast Fourier transforms]. It uses a movable optical font to directly search for characteristic parameters, and it uses a screen editor function to delete useless signals at the same time as it provides such high-level machine performance as combined command loop operations and signal dumping.

The 200 intelligent machine fault analyzer combines into one unit such devices and functions as transducers, vibration testing, data acquisition, A/D conversion, data processing, and screen printing, and can be used at factory sites to do on-line testing of machines and equipment in operation, as well as to determine the nature and location of faults and their degree of seriousness.

Automatic Chinese-Character Compression/Expansion Software Announced

40080175c Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 16, 26 Apr 89 p 14

[Article by [surname only] Sun [1327]: "Beijing Aerospace University Produces Character-Base Automatic Compression/Expansion Software"]

[Text] The Imagery Center of Beijing Aerospace University recently developed automatic compression and expansion software for Chinese-character character bases. This software package can arbitrarily enlarge or compress dot-matrix character bases and vector character bases, thereby generating dot-matrix and vector character bases of different sizes. The unique functions of this software, its ease of use, and the retention of the attractiveness and features of the fonts after expansion or compression have attracted great interest.

In addition, the high-quality dot-matrix character-base automatic generation software and vector character-base automatic generation software that were developed earlier by this center are relatively complete character-base generation software [packages] that in comparison with other similar products are seen to have advanced processing methods and attractive generated fonts; they take up little space, completely automate the entire process, and do not need manual intervention.

Four fonts for the GB 1 and 2 [i.e., National Standard level-1 and level-2] dot-matrix character bases--Song, pseudo-Song, script, and boldface--have been prepared for hundreds of Chinese-character laser printer systems in use by dozens of units such as the Central Committee General Office, the Central Commission for Discipline Inspection, the Ministry of Foreign Affairs, the Ministry of Public Security, and the Ministry of Astronautics Industry. The GB 1 precision vector character base (including single-line and double-line Chinese characters) has been well received by relevant entities, and it is being prepared for distribution.

Research on Reducing Overhead in Parallel Processing

40080183 Beijing JISUANJI XUEBAO [CHINESE JOURNAL OF COMPUTERS] in Chinese Vol 12 No 6, May 89 pp 321-327

[Article by Liu Guizhong [0491 2710 0112] and Ci Yungui [1964 0061 2710]: "Development of Parallelism at the Compound Function Level in Dataflow Computers"; manuscript received 8 May 87]

[Text] Abstract: The principal reason for excessive overhead in dataflow computers is that the particle size [or "granularity"] of parallelism is too small. This paper reports on research regarding the introduction of the development of parallelism at the compound-function level as incorporated into a dataflow computer model, and it discusses methods of implementation at the abstract machine level of the SDS model, describing the SDS-1 [Synchronous Dataflow System 1] system, a model computer based upon these principles. [For a report on the certification of the SDS-1, see JPRS-CST-88-004, 16 Feb 88, p 26.]

I. Introduction

Dataflow computers have a broad future for development, but in the realm of technology there is the problem of excessive overhead. The principal reason for this excessive overhead in dataflow computers is that the scale of parallelism is too low, which is to say that the granularity of the parallelism is too small. The parallelism in a system may be divided into several grades, as for example, job-level parallelism, process-level parallelism, function-level parallelism, and instruction-level parallelism. In dataflow computer models, there are no levels of parallelism this clear, and all levels of parallelism are invariably changed into instruction-level parallelism for implementation. Too high a cost is paid for this inappropriate reliance on instruction-level parallelism. For example, arrays must be broken into parts for processing, which is quite troublesome. If the focus is on function-level parallelism, we would design various functions for processing arrays, as for example such functions as vector addition, subtraction, multiplication, and division. Although using data to drive the execution of these functions appears to be sacrificing the parallel processing between the elements, if we use the pipeline processing mode, the cost will be minimal and the parallelism can be developed. Another reason for large overhead in the operation of dataflow computer models is that there is no control, as the operation is asynchronous.

To overcome this problem with dataflow computers, we must: 1) raise the level of parallelism; 2) while maintaining a parallel condition, introduce necessary controls to reduce instruction-level parallel overhead.

This paper reports research only on how to develop parallelism at the compound-function level.

II. The Function Language VAL and Abstract Computer of the SDS Model

2.1. SDS, a Model Integrating the Synchronous With the Asynchronous

On the basis of an improved dataflow graphical chart DFGC, we have built the SDS (Synchronous Dataflow System), a dataflow system model that integrates the synchronous and the asynchronous, used as a shared base for a next-step high-level dataflow language and system structure design.

The higher levels of the SDS model use functional relation charts as descriptive tools, the goal of which has been to describe relations between functions, which will then develop parallelism at the function level. The nodes of functional relation charts are compound functions.

Compound functions are where the basic operations in DFGC are compounded through a limited number of applications and combined under four different conditions, after which the names of these functions replace those of the corresponding DFGC sub-graphs, that is, they form functional relation charts. This process is called "compound-function partitioning."

It has been proven that functional languages without side effects, as for example where all functions are strict functions (whereby this kind of language is said to introduce transparency), can undergo the replacement just described without affecting the meaning.

2.2. The VAL Language and the Abstract Computer of the SDS Model

The VAL language is a functional language designed with the dataflow computer model in mind, and it is fundamentally in keeping with the demands of the SDS model, the two being largely mutually suitable. As the SDS model can properly represent undefined values, this provides a basis for introducing various error values and exceptional processing into VAL. But there are still areas within each that are not mutually compatible. The primary problem is that SDS is a dual-level model, where the higher level is the functional relation chart, the nodes within which are compound functions. This is a program unit larger than the VAL operations, but smaller than the modules, that is, one module does not necessarily correspond to a compound function, but rather corresponds to a functional relation chart, in which there are many compound functions. Some statements in the VAL language, as for example forall, which begins parallel development, must be converted into several compound functions for parallel execution; the earliest document on VAL [7] introduces the cyclic iteration construct, which is in conflict with the demands of the SDS model, and for which reason we have eliminated VAL's iterations, and allowed recursion.

The VAL compiler does an independent compilation of each module in a program, only finally chaining all into runnable object code; the task of the compiler is to convert each source routine module into a functional relation chart, then converting each compound function into a DFGC chart. Generally speaking, the compiler must first convert the source program into a DFGC chart structured by atomic operations, then in accordance with this structure, partition the result into different compound functions. To implement VAL, we also provided modules in the SDS model that correspond to the language components; this can then be seen as an abstract machine of the SDS model that implements VAL. One of the tasks of the compiler is to convert the source program into these modules. A description of the SDS abstract machine is as follows:

(1) The Form of the Modules

A VAL program module is an external function; the form corresponding to the module is as shown in Figure 2.2.1 (a), and the name of the external function is f, which has been converted into a functional relation chart. This may be divided into three parts. One is begin f, which is an independent compound function; it is used only for transferring initial parameters. The second is return f, which is also an independent compound function, used to return calculated results to the caller. The third part is the function body, made up of several compound functions, where the corresponding function calls are converted into a compound function apply f, as for example in Figure 2.2.1 (b), and the recursion function is also converted in accordance with the form just described.

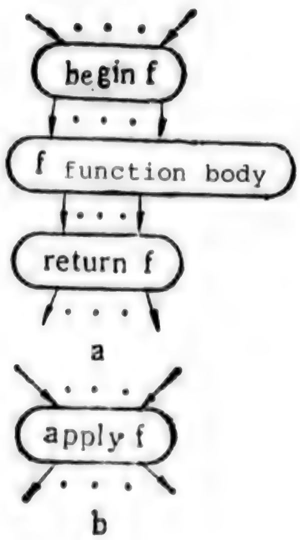

Figure 2.2.1

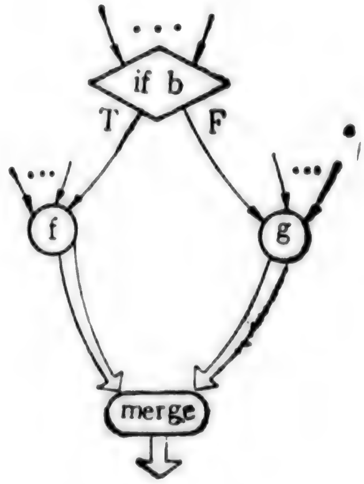

Figure 2.2.2

(2) The Form of the Conditional Structures

The basic syntax of the VAL conditional structure is if b then f else g endif, where the corresponding functional relation chart is as shown in Figure 2.2.2.

Each node in the figure is a compound function. The if b statement calculates the Boolean expression b, then sends the result to f and g if the result is true. Thus, when the control mark at output terminal T is true, there is a triggering operation when the other data values of f are reached. At this time, the control mark at output terminal F will be false and g will not run, only outputting ff. ⊥. merge will output two groups as one by merging their corresponding control marks.

(3) The Form of the forall/construct, forall/eval Structures

forall is a VAL syntactic structure used to clearly express parallelism, the basic form of which is:

```
forall i in [expression]
            [definition portion]
       the forall body

endall

forall body :: = construct expression/eval forall-op expression

forall-op :: = plus/times/min/max/or/and
```

where i is the subscript and the expression after in is a 2-element integral-form expression which gives the range of the subscript i. The definition portion provides some expressions to which is attached the value name forall and the body of which uses construct or eval to calculate the results, which constitute arrays or scalar values.

Example

```
forall i in [1,16]

  x = square-root ((A(i)-a)**2)+((B(i)-b)**2)

  construct x

  eval plus x

endall
```

The syntax is: for each element of the vectors A,B, calculate $\sqrt{(A(i)-a)^2+(B(i)-b)^2}$, which then forms a new vector, at the same time generating a scalar.

The form corresponding to forall is as shown in Figure 2.2.3, where forall is a compound function and which only performs a data transfer and dynamic generation of several functions that may be run in parallel. forall definitions are multiple compound functions used for calculation, while construct and eval are two compound functions for constructing a new array and a new scalar value, respectively.

The compound function relation chart for the example above is shown in Figure 2.2.4.

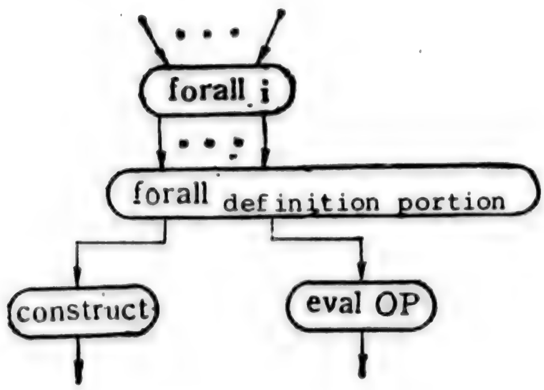

Figure 2.2.3

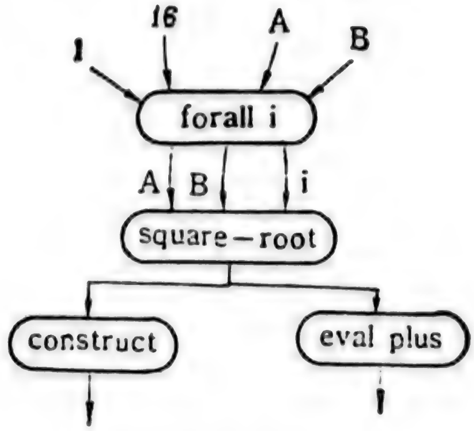

Figure 2.2.4

2.3. The Development of Parallelism at the Compound Function Level

2.3.1 The Dynamic Attributes of Functional Relation Charts

Functional relation charts are like large dynamic dataflow charts. What we mean by "dynamic" is that it is permissible for several tokens to appear on a single line in the functional relation chart. Obviously, a compound function can have several examples running at the same time. This is how parallelism is developed.

There are two ways to implement dynamic functions, one being to copy a new compound function whenever needed, and the other to divide the description of compound functions into two kinds: static and dynamic. When necessary, only the dynamic portion is created, both sharing the static portion. The first method is simpler, but copying the entire thing requires a lot of overhead. To reduce that, we use the second method.

2.3.1.1 A description of the compound functions

A static description of the compound functions is composed of four parts.

(1) The compound function head

This is the extant signifier of the compound function, which describes data relevant to the attributes and records of the compound function.

(2) Local name tables

These are tables for the input/output data names and internal data names of the compound functions, as well as for constant names.

(3) The DFCC chart for the compound functions

This is the dataflow routine for the particular compound function.

(4) Target function name table

This is the ordered set of the target functions to which must be sent the calculated results of this compound function.

2.3.1.2 The activity records of the compound functions

The dynamic portion of the compound function is two activity records, which are like the process working sets of traditional languages. The activity records are used for recording the input data for functions. The definition is as follows:

Function input data activity record

(suf1, suf2, state, in-count, reg1, ..., regn, act)

where:

suf1 and suf2 are two suffixes for functional system names, and are used to distinguish dynamically generated equal functions from different samples:

state = { 0 indicates normal working state.
1 indicates an acceptance state. When the control mark is false, state is set to 1 and the acceptance state is entered, at which time the function accepts input data. When the data reaches saturation, action is taken, but calculations are not begun; this only generates a non-defined result for the target function;

in-count input data calculator. When one datum is input, the calculator subtracts 1, and when this reaches 0, action is taken;

reg1--regn N number of token registers. These are 2-element groups (C,D), where C is the control mark and D is the data.

act activity record pointer, which points to the next activity record. Activity records for the same function all use the activity record pointers to chain together a single linked list, where the activity record pointer at the function head points to its head.

2.3.2 The Dynamic Derivation of Functions

In addition to being able to execute unrelated compound functions in parallel, the SDS model also allows dynamic derivation of several examples from a function, then running them in parallel. On the one hand, this improves the degree of parallelism, and on the other is used to implement function recursion calls.

Dynamic derivation of functions is jointly accomplished by the three compound functions applyF, beginF, and returnF.

The process of dynamic derivation of functions is as follows:

(1) Request an activity record

Chain to the returnF activity record link, and store the suffix sufl in the returnF activity record;

(2) Generate a new first suffix

sufl' = sufl-generator; change the first suffix in applyF and returnF to sufl';

(3) Take out the applyF activity record (suffix is sufl' and suf2)

Take out from among the activity record links, and link in the activity record links of beginF; begin execution of beginF, and when the compound function F has completed execution, finally run the returnF return-to-original-caller function, and return to the process as follows:

1. Extract the system names of the original suffix sufl and applyF from the returnF activity record; extract the compound function header from applyF;

2. Change the suffix sufl' in the activity record of returnF to sufl;

3. In accordance with the target name table DES for sufl, suf2, and applyF, retrieve the activity record of the target function, and send the input data in the activity record of returnF to the activity record of the target function.

2.3.3 The Dynamic Expansion of forall

According to the semantics of the forall structure, it is a similar processing of the elements in an array, and when the elements within the array are not related, they may be executed in parallel.

In the SDS model there are two processing modes for forall: one is parallelization, in which the forall structure is dynamically expanded, generating examples of equal quantity to the elements of the array and executing them in parallel; and the other is vectorization, where an array is divided into segments of appropriate size, where each segment generates an example of forall.

The reason for using two different modes is to keep the size of the granularity of the parallelism appropriate and to reduce overhead, as for example in the following forall structure:

```
forall i [1:128]
   construct A[i]+B[i]
endall
```

As far as the elements in each array A and B are concerned, they are simply added once. If the structure just described is processed in parallel, i.e., it is expanded into 128 compound functions, the operations of each compound function are only that one addition, which is no different from instruction-level parallelism. For this reason, the vectorization method should be used, as for example partitioning A and B into B segments, where each segment has 16 elements and is to be processed by one compound function. At compile time, this generates a compound function, dynamically generating B number of compound functions, where each compound function processes 16 elements in a dataflow method. Not only does this develop parallelism, but it also reduces overhead.

The expansion process of the forall structure is similar to that of the apply structure, the only difference being no revision to suf2. We will not repeat that process here.

III. The System Structure of the SDS-1 System

3.1. The Hierarchical Structure of the SDS-1 System

The SDS-1 system has a hierarchical structure, which corresponds to the hierarchical structure of the SDS model. By nature this is a tree structure. In the root node are a global controller and storage, which are connected with several local controllers, and also with several processors. The compound functions and data are all stored in the root node, after which they are sent to local storage, then under control of a local controller to several processors for parallel execution. The results are then sent back to local storage, after which they are sent to global storage. The processors cannot directly communicate with each other, but rather must be connected via local storage. The individual processor components (which are made up of local controllers, local storage, and several processors) can also not directly communicate with each other.

The SDS-1 structure is shown in Figure 3.1. The GCU noted therein is the global controller, GFU is the general-purpose function processor unit, VPU is the vector processor unit, PM is the program memory, AM is the array memory, and NETWORK is the connecting network [3].

IV. An Evaluation of the Performance of the Model Computer and the SDS-1 System

4.1. A Description of the Model Computer

We had two goals in making the model computer: one was to run various standard programs on this computer to test the relation between operating

speed and the number of processing units, to study the actual degree of parallelism in the system and the size of its overhead, and consequently to prove the superiority of the SDS-1 system structure; and the other was to develop a hardware compiler for the functional language VAL and especially to research effective and optimal algorithms for partitioning compound functions. The SDS-1 structure is divided into two levels, which develops two layers of parallelism. In consideration of the restrictions of the actual situation, the model computer only simulates the higher level of the SDS-1 and develops one layer of parallelism for the compound functions.

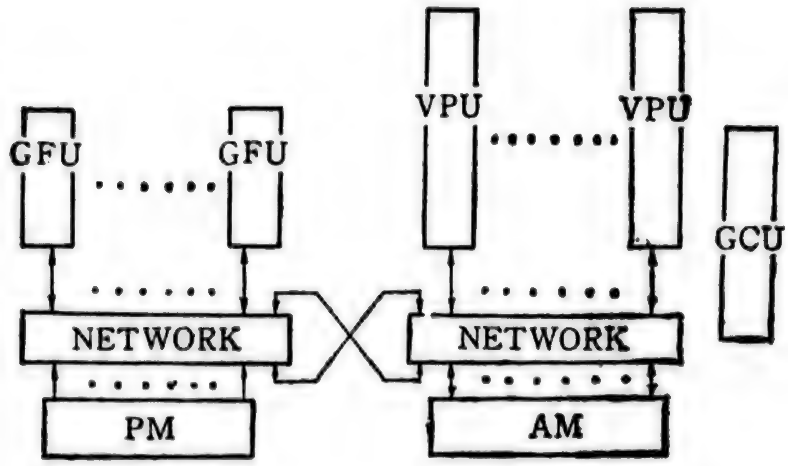

Figure 3.1. Structure of the SDS-1 System

The model computer is constructed of one host microcomputer and four single-board computers. Through a group bus, they share main memory, communicate with each other, and constitute a tightly-coupled system.

The host microcomputer manages peripherals and communicates with the outside world, and it executes the functions of the SDS-1 GCU unit and main memory (including PM and AM), while the four single-board computers simulate the general processor unit of the SDS-1, and they actually execute the various operations of the compound functions. The SDS-1 vector unit is highly demanding of the interconnecting network, and since the model-computer single bus passband is too low, this demand cannot be met and so has not yet been simulated.

In accordance with the application fields for the SDS-1, we have selected three typical programs to run on the model computer, have kept statistics on relevant data, and have tested relevant performance. These three programs are matrix multiplication, average error, and collation.

4.2. Measured Results and Evaluation

We ran three test programs on the model computer, from which we obtained certain data (see Table 4.1). See Figure 4.1 for the curves produced by this data regarding time of program execution and relations between processing units.

Table 4.1. Average Results

Number of units	1	2	3	4
System execution time	224190	133870	123290	101880
GCU execution time	490	480	490	460
GCU/SDS	0.2%	0.36%	0.4%	0.45%
t_A/t_1	1.0	0.597	0.55	0.45

Notes: 1. GCU/SDS is a comparison between GCU execution time and SDS system execution time;
2. t_A/t_1 is a comparison between the system execution times for n processor units and one-processor.

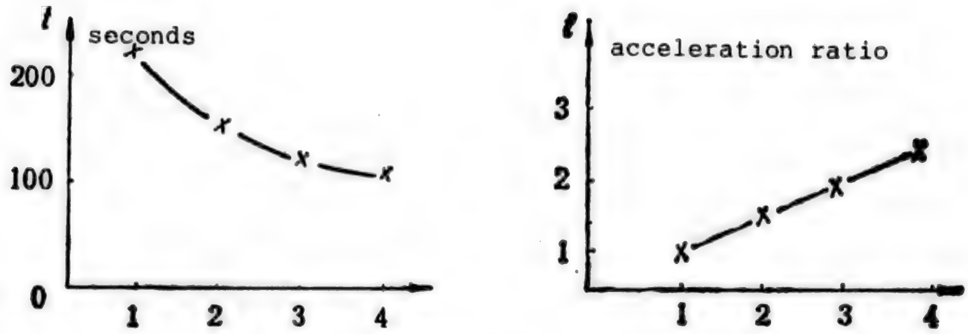

Figure 4.1

As can be seen from the statistical data and curves, system performance is quite good. There were only four compound functions in program number two, but when executing, the system dynamically generated 64 functions that could be executed in parallel, which effectively exploited the parallelism inherent in the program.

When there are three or four processing units in the model computer, program execution speed cannot be shortened to one-third or one-fourth that of one unit. We can see from the original statistical data that the primary reason is because communications on the single bus of the model computer are so congested that the external units are forced to wait for data. For example, within the same time, unit 0 executed 44,657 instructions, generating 11,680 floating-point results, while unit 2 could only execute 31,582 instructions, generating 8,384 floating-point results. Unit 2 was in a wait state for nearly one-third of the time. This shows that the single bus is a bottleneck for the model computer. The SDS-1 system structure uses an interconnection network, not a single bus; there are eight functional processor units, which is not too many, and although there are 80 processors, they do not directly communicate with main memory. For these reasons, use of the interconnection network can effectively resolve the memory access problem.

Execution time for the SDS-1 GCU global controller in the model computer was not even 1.0 percent of the system execution time. This shows that the

system overhead from using compound functions and dynamic derivation is not worth consideration, as the system can effectively reduce the overhead of developing instruction-level parallelism. This proves that it is reasonable to develop compound-function-level parallelism.

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Software Tool Developed for Detection, Eradication of Computer Viruses

40080205 Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 23, 14 June 89 p 1

[Article by Yu [1342]: "Beijing University's Mechanics Department Develops Software Tool for Detection and Eradication of Computer 'Viruses'"]

[Text] Editor's note: After the report "Computer 'Virus' Programs Discovered One After Another in China," published on page one of our issue No 20 [24 May 1989], we received a number of letters and phone calls from readers saying that they also had recently experienced faults with their PC's--faults similar to the "virus" phenomena described in the report. The readers wanted to know if there was a way to diagnose whether or not this type of phenomenon was a computer "virus," and how to eradicate this kind of "virus." For the reader's reference, we have therefore published the following special article. [End of note]

Two kinds of virus have now been discovered among various types of domestic PC's that run with the DOS system. The two kinds belong to the operating system variety and the shell variety, respectively. The former is transmitted quite rapidly, and the latter is categorized as a "harmful" virus. In addition to being spread by copying, these two kinds of virus can also infect when several programs are run.

The operating system virus manifests itself as follows: at times some small spheres appear on the screen and move around, or sometimes the monitor display is abnormal (and also incomplete). A simple discrimination method is to use the CHKDSK command audit disk, which will permit one to discover which sectors have been damaged (the floppy disks bearing the "virus" normally have 1024 bytes of bad sectors). Since this virus resides within the computer, it spreads unusually fast.

The shell variety of virus is generally difficult to perceive. It is only when the infection is very severe that the symptoms become obvious: when some programs are run, the screen display immediately goes completely blank, after which the machine automatically starts again. Or, when the computer is turned on, one sees the disk drive working without interruption, but one cannot enter normally into the DOS system--the machine continues to repeat the start-up. This kind of virus directly infects files, and those files which have caught the infection can continue to infect other files [previously] normal. In addition, this kind of virus can also completely destroy some documents; the destroyed files then

manifest the aforementioned phenomenon, hence the usage of the term "harmful" virus. Analysis has revealed that the length of the destroyed files does not vary, and that the length of the infected files somewhat increases (the length of the increase is generally 648 bytes). One can therefore make use of this result in detecting whether or not a hard disk (or floppy disk) in use has caught the shell-type "virus." Xi Hongyu [1153 4767 1342] from the Department of Mechanics at Beijing University has now isolated the two viruses and made an automatic-detection software tool that can be used to determine if a floppy disk has or does not have this kind of virus. In addition, they [Xi and his associates] have also developed a software tool that can automatically restore files and disks infected by the virus as well as eradicate the virus. It will be available for the vast number of PC users in the near future.

Method Discovered for Counteracting Computer Viruses

40080218b Beijing DIANZI SHICHANG [ELECTRONICS MARKET] in Chinese 22 Jun 89 p 4

[Article by Heng [5899]: "Method for Detoxifying and Immunizing Computers"]

[Text] Computer "virus" programs are many and varied, and for a specific type of "virus" program one must have a definite technique for detoxification and immunization. This article introduces a method discovered by the author for detoxifying and immunizing against a [specific] "virus"; before presenting the method, a short description of the software and hardware environment in which this virus operates is given, as well as its forms of expression.

This virus's hardware environment includes the IBM-PC/XT and compatible computers such as the [Great Wall] 0520 [microcomputer]; the [affected] software is based on ROM BIOS. The virus can be set off in any executable applications software environment, such as BASIC, dBASE III, and Wordstar. In the English-language mode, the monitor shows spherical dots moving around just like table-tennis balls. In the Chinese-language mode, with middle-resolution monitors, the screen rolls up or down and reacts very slowly, but one can discern the movement of the small spheres. When printing reports in the 24-dot-matrix Chinese-character [format], this results in machine deadlock. System disks formatted by the FORMAT/S instruction cannot start, and 3+ network system software can have pilot failure [yindao shibai]. Research and analysis reveal that there are now available two methods for eradicating the virus and marking [a disk] for immunity, so that a detoxified disk will not again be infected by this "virus." The first is to use a debugging software tool, which is simple and easy to run, but requires use of DEBUC [as printed] software. The second is to use a detoxifying and immunizing program. The latter method is more convenient and reliable and one can avoid mistaken actions; in fact, this program is the automated mode of the aforementioned manual operation. A description of the first method follows so that units subjected to this virus infection can eradicate the virus by themselves.

First, one prepares a disk with the DEBUC system; it is of no consequence whether or not it has the virus. What is important is to strictly execute the following steps in order to eradicate the virus and to put on the immunity mark.

```
Step 1: A>DEBUC
2: LCS: 100 0 0 1
3: D2F0 2FF
    OD8E: 02F0  FE  EB  OD  01  OC
    00  01--00  A0  02  00  57  13  55
    AA
```

```
4: LCS: 100 02  A1  1; 2A1=02A 0+1
5: D2F0 2FF
    0D8E: 02F0  00 00 00 00 00 00 00
    00--00 00 00 00 00 00 55 AA
6: E2FC
    0D8E: 02FC  00.57  00.13  55.AA
7: WCS: 100  00  1  8--Q
```

Finally, one must take note of: (1) the mark of this "virus" is "1357" and the addresses of the aforementioned operating mode are 2FC, 2FD. If the immunity-marked disk also has a "1357," the contents of addresses 2F9 and 2FA will have nothing in common; the former has a specific non-zero contents, while the latter is definitely zero. (2) After execution of the aforementioned step 7, one must not carry out any read-disk operations on the disk at all; otherwise, the disk can again be infected by the "virus." After rebooting with a thus-sterilized system disk, the computer system cannot again catch the "virus."

More Numerically Controlled Machine Tools Announced

40080179a Beijing ZHONGGUO DIANZI BAO in Chinese 28 Apr 89 p 3

[Article by Liu Shu'en [0491 3219 1869]: "Institute 706 Makes Many Contributions to the Cause of China's Numerically Controlled Machine-Tool Effort"; see also JPRS-CST-89-010, 16 May 89, p 97]

[Text] Institute 706 of the Ministry of Aeronautics & Astronautics Industry is a scientific research unit engaged in computer applications research. Since the early 1980s, and in accordance with China's needs, this institute has focused on developing and researching civilian products, and all in all they have successfully developed and released dozens of new products in microcomputer applications for the fields of production process automation and office automation . Of special note is the use of microelectronics technology to transform traditional industry and develop digitized, automatic, and intelligent new products that integrate the mechanical with the electrical, in which field they have made many contributions.

Since 1981, this institute has developed and manufactured several microcomputer control systems for linear cutting machines, high-precision planar grinders, upright drills, and laser machining tools. These include seven products in the MNC80 series of low-cost [microcomputer] numeric controllers, of which more than 700 have been manufactured, and the numerical control system they developed, together with the DK-7732 linear cutting machine tool set from the Beijing Machine Tool Plant No. 4; this set has been sold throughout China, as well as to the U.S., West Germany, Indonesia, Thailand, Algeria, and the region of Hong Kong and Macao.

In recent years, this institution has also developed and released a total of six new products: economical models including a cylindrical grinder, a jig borer, a milling machine, and drilling center, and a medium-to-high grade numerically controlled system--the MNC 861-866 series. Among these, the MNC 862 uses an Intel 8086 as its CPU, displays with either a CRT or LEDs, and is equipped with medium and large-scale integrated circuit dual coordinate systems. It uses DC

servo-motors and speed control units, as well as pulse coded disks for feedback measurement units. This system can be upgraded to a completely closed loop control system.

The MNC 866 uses the STD bus with an Intel 8088 as the CPU. It is equipped with a CRT display, and is a semi-closed loop ordinary numerical control system with a pulse coder as its checking component. It is powerful, does calculations quickly, has much software, and is the economical numerically controlled model designated by the Ministry of Machine-Building and Electronics Industry.

The MNC 864 numerical control system is a basic system that can be used for on-site cutting and shearing, and for upgrading. It can be joined with a milling machine, jig borer, drilling center, and vertical machining center to form a completely closed-loop numerical control system. The system uses the S-100 bus, is constructed of modules, and has such functions as self-diagnostics, dynamic graphics display, and interactive editing and learning. It is one of China's more advanced high-grade numeric control systems.

Institute 706 is now moving toward complete-function numerical control systems, machining centers, flexible manufacturing cell systems, and computer integrated [manufacturing] systems.

Real-Time Parallel Image Subtraction by Multi-Wave Mixing in a Fe:$LiNbO_3$ Crystal

40080170 Beijing WULI [PHYSICS] in Chinese Vol 18 No 3, Mar 89 pp 173-174

[Article by Zhao Mingjun [6392 2494 0689] and Li Yulin [2621 5148 2651] of Xian Institute of Optics and Fine Mechanics, Chinese Academy of Sciences: "Real-Time Parallel Image Subtraction by Multi-Wave Frequency Mixing Using a Fe:$LiNbO_3$ Crystal"]

[Text] Abstract:

Based on a study of multi-wave frequency mixing in a Fe:$LiNbO_3$ crystal, we combined the Mach-Zehnder optical path and a phase-conjugate mirror to build a real-time parallel image subtraction and exclusive OR logic system. This system is not affected by the arm-length difference and dielectric fluctuation of the Mach-Zehnder optical path. It provides an important technique for real-time optical information processing.

Image subtraction is an important aspect in optical information processing. How to complete this operation in a fast and simple manner has great significance to optical logic operation and to the development of optical computers. There are several techniques to deal with this problem.[1-3] However, there are other problems such as precision reset and developing negatives. The emergence of the optical phase complex conjugate in recent years offers an important real-time means for this operation.[4] For example, real-time image subtraction could be achieved by four-wave mixing in a BSO crystal[3-6] or by degenerate four-wave mixing (DFWM in a Fe:$LiNbO_3$ crystal.[7] These methods are based on a double-exposure holographic process.

Recently, Sze-Keung Kwong et al. achieved real-time parallel image subtraction by using the self-pumping effect of $BaTiO_3$.[8] $BaTiO_3$ [barium titanate] crystal is not yet available in China, but Fe:$LiNbO_3$ is widely used. In this study, based on multi-wave mixing in a Fe:$LiNbO_3$ crystal,[9] a real-time image subtraction optical operating system is established by combining the Mach-Zehnder optical path and a phase-conjugate mirror. This system is independent of arm-length difference in the Mach-Zehnder optical path and dielectric fluctuation.

I. Experimental Principle

As shown in Figure 1, T_1^1 and T_2^1, pumping wave E_1 and E_2, T_1^{1*} and T_2^{1*}, and the Fe:$LiNbO_3$ crystal c form a six-wave mixing system. Its details are shown in reference [9]. The Mach-Zehnder optical path is based on the principle that a plane wave E_o is split in two by a beam splitter BS_1. The two beams pass through two objects (T_1, T_2), respectively. T_1 and T_2 are the corresponding transmittance. The transmissive images of T_1 and T_2 are reflected by a mirror before entering a Fe:$LiNbO_3$ crystal as the object signal (T_1^1, T_2^1) for multi-wave mixing. Together with pumping wave E_1 and E_2, they are subject to a higher-order non-linear effect in the dielectric which resulted in the generation of conjugate waves T_1^{1*} and T_2^{1*}. T_1^{1*} and T_2^{1*} travel back to the reception screen C through BS, following the same route. The physical process can be described as follows:

first step:

$$E_o \xrightarrow[\text{by } BS_1]{\text{reflected}} E_o r \xrightarrow[\text{thru } T_1]{\text{transmitted}} T_1 E_o r = T_1^1 \xrightarrow[\text{conjugate mirror}]{\text{entering phase-}} T_1^{1*}$$

$$tr^*E_o^*T_1^* \xleftarrow[\text{thru } T_1]{\text{transmitted}} E_o^*r^*T_1^* \xleftarrow[\text{route}]{\text{following original}}$$

second step:

$$E_o \xrightarrow[\text{by } BS_1]{\text{transmitted}} E_o t \xrightarrow[\text{thru } T_2]{\text{transmitted}} T_2 E_o t = T_2^1 \xrightarrow[\text{conjugate mirror}]{\text{entering phase-}} T_2^{1*}$$

$$t^*rE_o^*T_2^* \xleftarrow[\text{by } BS_1]{\text{reflected}} E_o^*t^*T_2^* \xleftarrow[\text{route}]{\text{following original}}$$

where r and t are the reflectance and transmittance of the beam splitter, respectively.

third step:

Both beams follow the original path to return to screen C. At this time

$$I_c = E_o^* (T_1^2 r^* t + T_2^2 r t^*). \qquad (1)$$

Based on Stokes law,

$$r^* t + rt^* = o \tag{2}$$

From (1) and (2) we get:

$$I_c = E_o^* r^* t \; (T_1^2 - T_2^2). \tag{3}$$

Thus, parallel image subtraction of image I from II is realized on screen C.

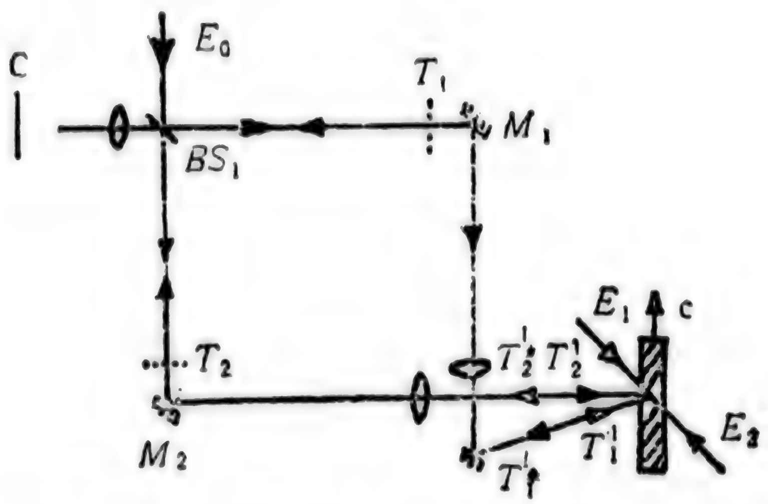

Figure 1. Principle of Real-Time Parallel Image Subtraction Using Mach-Zehnder Phase-Conjugate Six-Wave Mixing Technique

Based on the above analysis, any phase delay or distortion due to arm-length difference or dielectric fluctuation in the optical path can be eliminated by the phase-conjugate mirror.

II. Results and Discussion

A 50-mW He-Ne laser was used as the light source in the experiment. The diameter of the beam splitter is 30 mm, and its transmittance is 40 percent. Six-wave mixing was carried out under the small-signal approximation condition, i.e., T_1^1 , T_2^1 ((E_1, E_2. The crystal is $LiNbO_3$ doped with 0.1-percent iron.

Figure 2 shows the result of image-contrast reversal.

(a) (b) (c)

Figure 2. Image Reversal by Subtracting T_1 and T_2

(a) transmissive image of object (T_1)

(b) transmissive pattern of "m" (T_2)

(c) image reversal after subtracting T_1 and T_2

(the black ring represents the edge and is not included in operation)

From (3), if the system only responds to the absolute value after subtraction, it is possible to achieve an exclusive OR logic operation for T_1 and T_2. Let T_1 and T_2 be 1 and 0, respectively. The results of these logic operations are shown in Table 1. We are investigating this area.

Table 1. Exclusive OR Logic Operations

In summary, this system is not limited by the arm length of the interferometer and is easy to use and provides results on a real-time basis. It is an important technique for real-time optical information processing.

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New Tunable Dye Laser Developed

40080218a Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 7, 20 Jul 89 p 447

[Article by Ji Zhong [4764 6988]]

[Summary] A new tunable dye laser developed by the Chinese Academy of Sciences' Shanghai Institute of Optics and Fine Mechanics has been tested to certify it to advanced international standards for the eighties. The new laser utilizes a Nd^{3+}:YAG [neodymium^{3+}:yttrium aluminum garnet] frequency-doubled laser [source] and a frequency-tripling laser pump. Output wavelength is automatically adjusted via microcomputer control of the grating-prism system and is automatically displayed. The continuously tunable wavelength range covers the entire visible spectrum (0.42-0.71 micron), laser pulse width is 30-50 picoseconds, average power is greater than 2 milliwatts, peak pulse power is greater than 6 megawatts, and the laser spectral line width is about 0.09 nanometer. Over the entire tunable range, the wavelength readout is accurate to more than 0.5 nanometer.

Indium-Antimonide Crystal Growth in Microgravity Environment

40080172 Beijing KEXUE TONGBAO in Chinese Vol 34 No 5, Mar 89 pp 340-342

[Article by Zhang Fangqing [1728 0119 3237], Zhang Li [1728 5461], Chen Guanghua [7115 0342 5478], Shen Mingzhi [3088 2494 2535], and Yan Guohong [2518 0948 3163] of the Lanzhou University Physics Department and by Da Dao'an [6671 6670 1344], Huang Liangfu [7806 5328 3940], Xie Xie [6200 3610], and Tan Xiaochen [6151 2556 5256] of the Lanzhou Physics Institute; manuscript received 30 Mar 88]

[Text] Key words: indium-antimonide crystal growth, microgravity, impurity streaking

Space processing of materials has attracted enormous attention in recent years. China carried out its first materials processing experiment in space in a microgravity environment using a recoverable satellite launched on 5 August 1987. In the experiment, a directional normal solidification method was used to remelt and recrystallize the InSb monocrystalline material. This experiment employed an all-purpose crystal processing oven. GaAs material was placed inside the oven and the InSb sample was placed on one side of the oven. Other materials of various types also were placed at different locations inside the oven. We have seen no other reports of the simultaneous processing of many different materials in the same oven. The microgravity level of the crystal processing on the satellite during the period in which the power was on was estimated at better than 2×10^{-4} g (g is the ground surface standard gravity acceleration).

We first took a Zn-doped InSb monocrystal (the doping concentration was approximately $\sim 10^{16}/cm^3$) cut from a 5-cm-long square crystal rod grown on the ground along a <111> direction and sealed it inside a cleaned quartz tube at a vacuum of 1.33×10^{-3} Pa. We then placed the sealed quartz tube at one side of the all-purpose crystal growing oven. In space, it was heated for 90 minutes and then cooled naturally. To facilitate comparison, we did a similar experiment on the ground with an InSb crystal cut from the same rod in the same processing oven under identical temperature conditions.

I. Experimental Results and Discussion

1. Appearance and Shape

Under space microgravity conditions, the effects of surface tension gave the exterior of the sample recovered from space a cylindrical shape. The cylinder diameter was homogeneous and the sample surface was smooth. The sample could move freely within the quartz tube before the quartz tube was opened. This indicated the absence of obvious wetting effects between the sample and the quartz walls. In contrast, the ground surface sample was wedge-shaped and wider toward the hot end. Moreover, the sample was strongly bonded to the walls of the quartz tube, indicating obvious gravity effects. It is apparent that materials processing under microgravity conditions can prevent contamination of the material by the walls of the container. The exterior of the sample is shown in Figure 1 [photograph not reproduced].

2. Impurity Streaking

The space sample and ground sample were both etched for 60 seconds along the direction of growth using a CP-4 etchant (1HF + $1CH_3$-COOH + $1KMnO_4$). An S-450 scanning electron microscope was used to examine their appearance. We discovered obvious impurity streaking in the ground sample, as shown in Figure 2a [photograph not reproduced]. All sites on the space sample were examined repeatedly and no impurity streaking was observed, as shown in Figure 2b [photograph not reproduced].

The reason is that during crystal growth on the ground surface, the existence of a gravity and temperature gradient created heat convection in the melted body. The convection caused temperature fluctuations in the solid-liquid interface and thus fluctuations in the rate of crystal growth. Fluctuations in the growth rate caused further differential solidification of impurities and thus the obvious growth streaks that were observed by etching the sample. Jin Gang [6855 0474] et al.[1] observed impurity streaking on both the (111) plane and (211) plane of the InSb crystal grown on the ground. In the space microgravity environment, the heat convection due to gravity was eliminated. This was the main reason for the absence of impurity streaks, and no impurity streaking was observed in the space sample. Witt et al. also observed similar results in M652 work.[2]

3. X-Ray Diffraction and Electron Diffraction

Electron diffraction experiments at different sites on the space sample were done using an EM-400 T analytical electron microscope, and there was very good conformity with the cubic crystal system monocrystalline diffraction spots. X-ray back-reflection Laue experiments also were conducted with a JPE X-ray crystal analyzer, and its diffraction spots were symmetrical in three dimensions. Its polar ray trace projection chart basically corresponded to the (111) plane standard plot, indicating that the crystal growth direction was basically along the <111> direction, but there was a small amount of deviation. This deviation may have been due to non-homogeneity of the slice.

4. Resistance Measurements

A single probe method was used to make horizontal cross-section radial resistance measurements of both the space sample and ground sample, with measurements for points at a 0.1 mm spacing. The relative variation in resistance is expressed as $\frac{\Delta\rho}{\bar{\rho}}$ where $\Delta\rho$ is the difference between the maximum and minimum resistance and $\bar{\rho}$ is the mean measured resistance. The relative variation in the resistance of the space sample was 3.6 percent, but was 34 percent for the ground sample. The relative variations in resistance are shown in Figure 3. The results show a substantial improvement in resistance homogeneity of the space sample, further confirmation of the improved doping homogeneity of crystals in a space microgravity environment.[3]

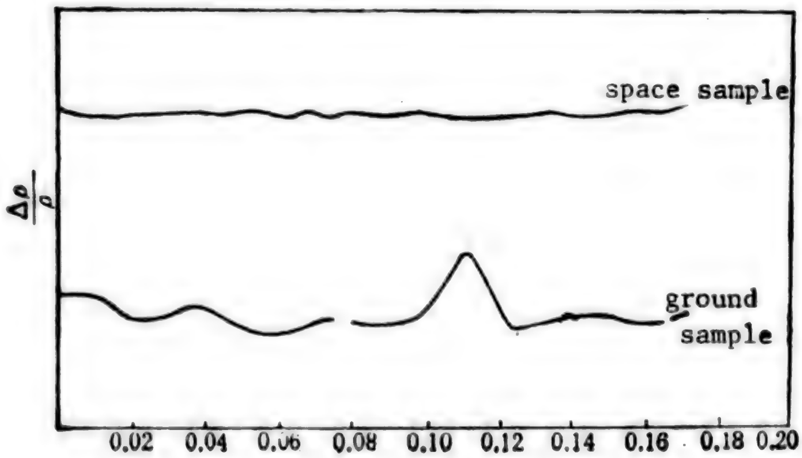

Figure 3. Plot of Relative Variation in Resistance

To summarize, in a space microgravity environment, good control of the conditions of crystal growth can produce better quality semiconductor materials.

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Satellite Television Broadcasting in Yunnan Province

40080188b Beijing ZHONGGUO DIANZI BAO in Chinese 12 May 89 p 1

[Article by Zhou Shiting [0719 4258 0255]]

[Text] With the recent completion of a satellite television earth station, Yunnan Province now has the capability of relaying television programs via satellites; it has also completed the construction of 882 television receiving stations [TVRO's]. These facilities have brought television broadcasting in Yunnan Province into the "satellite era."

During a meeting of television station managers held in Kunming City last April guidelines for future development of television broadcasting in the Province were established; the goal was to establish a province-wide satellite television network within a 4 year period. Specifically, it was agreed that in the 1990 time frame, independent satellite transponders will be rented to provide satellite broadcasts to farms and villages; by 1992, television receiving stations are expected to be available in most counties and villages. In addition, effort will be made to boost Yunnan Province's economy by accelerating the research and development of very-small[-aperture] systems [VSAT's] and home-use TVRO s.

Integrated Digital Network Established

40080188c Beijing RENMIN RIBAO in Chinese 16 May 89 p 2

[Article by Jiang Xinyuan [1203 2956 6678] and Le Mei [2621 3780]]

[Text] Beijing, 15 May (XINHUA)--As a result of the recent progress made in communications technology, China now has the capability to build a state-of-the-art integrated digital network (IDN) exclusively using Chinese technology and Chinese-built equipment. According to experts attending the "Engineering Certification Meeting for Joint Testing of a Stored-Program-Controlled [SPC] Digital Exchange and Optical Cable Communications System" in Beijing, the successful development of this key technology is a major step toward the proliferation of Chinese-made products in advanced communications systems.

SPC digital [telephone] exchanges and optical-cable communications systems are two of the new areas where a great deal of worldwide research and development efforts are concentrated. The DS-2000 SPC digital exchange and the multi-mode, long-wavelength, DS3 [34 Mbits/sec] fiber-optic communications system which just passed certification are equipment developed for the first time in this country. These pieces of equipment can be used to establish an integrated communications network for various types of digital traffic between exchanges. After more than 4 years of development and operational tests, the performance and communications quality of these pieces of equipment meet China's national standards and have also met requirements established by the International Telecommunications Union. By promoting their use in China's domestic communications network, we can reduce our dependence on foreign products in developing telephone communications for major urban areas.

The organization in charge of this engineering project is the Science Institute of the Ministry of Posts and Telecommunications; it will coordinate the efforts of 24 different organizations participating in the development under a subcontract arrangement. It has been reported that the research department is currently conducting tests on digital network synchronization and common-channel signaling in order to further improve the performance of the IDN. During the Eighth 5-Year Plan, efforts will be made to develop integrated services digital networks (ISDN) for carrying various digital services between the exchanges and the users.

Latest Developments in Fiber-Optic Communications

Two New Optical Power Meters

40080210 Beijing ZHONGGUO DIANZI BAO in Chinese 2 Jun 89 p 2

[Article by Wang Guangyun [3769 1639 6663]: "Two Kinds of Optical Communications Meters Now in Batch Production"]

[Summary] With a standards certification from the State Institute of Metrology and an approval from the Hubei Province Bureau of Measurement, two new kinds of optical communications meters developed as key projects in the state's Seventh 5-Year Plan by the Meter Plant of Engineering Company No 3 under the Ministry of Posts & Telecommunications have recently been put into batch production. These two are the HOP-1 high-sensitivity optical power meter and the POP-1 portable optical power meter. These meters are used for direct, reference, and comparison measurements of optical fibers as well as for averaging of the measured data, and incorporate functions such as automatic switch-over of the measuring range. The sensitivity of the HOP-1 can reach -85dBm [decibels above one milliwatt] (short wavelength) and -75dBm (long wavelength); wavelength selection is in the range 0.4-1.6 microns, and resolving power is 0.01dB. The sensitivity of the POP-1 can reach -[illegible]Bm and -55dBm [for short wavelength and long wavelength, respectively], with a resolving power of 0.01dB.

Active Optical Fiber Developed

40080210 Beijing ZHONGGUO DIANZI BAO in Chinese 6 Jun 89 p 3

[Article by Yu Yu [3768 1342]: "Active Optical Fiber (Neodymium-Doped) Developed"]

[Summary] Using the MCVD [modified chemical vapor deposition] technique, Research Institute 46 of the Ministry of Machine-Building & Electronics Industry has developed an Na^3-doped active optical fiber. This type of fiber, into which minute quantities of elements such as neodymium, molybdenum, and terbium are doped, is used as a principal component in fiber-optic lasers and fiber-optic amplifiers. Its pump absorption loss is 500-5500dB/km, laser loss is 1.25-50 dB/km, λ_c [cut-off wavelength] is less than 1.08 microns, optical-fiber length is 10-1000 meters, and [tensile] strength is greater than 150 grams/coiled-coil [i.e., compound-wound] monofilament. The production of this optical fiber will have great value in furthering domestic development of high-capacity and ultra-high-capacity coherent optical communications and optoelectronic technology.

Shanghai Producing Optical Waveguide

40080210 Beijing RENMIN RIBAO in Chinese 9 Jul 89 p 2

[Article by Xu Songhua [1776 2646 5478]: "Shanghai Begins Producing Optical Waveguide Fiber"]

[Summary] Shanghai (XINHUA)--A new optical waveguide fiber--a hair-thin glass fiber that can carry 20,000 simultaneous telephone conversations--was formally put into production a few days ago at the Xin Hu [2450 3337 "New Shanghai"] Glass Factory. Based on absorption of fiber-optic production equipment and technology imported from France and Switzerland in 1986, the factory had begun trial batch production in March of this year, and has already produced over 1000 kilometers of optical fiber, of which 400 kilometers have been turned over to relevant authorities.

Economic Analysis, Comprehensive Utilization of High Flux Engineering Test Reactor

40080169 Chengdu HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING] in Chinese Vol 10 No 2, Apr 89 pp 1-5

[Article by Lu Guangquan [0712 0342 0356] of Southwest Center for Reactor Engineering Research and Design at Chengdu; manuscript received on 16 Apr 88: "Economic Analysis and Comprehensive Utilization of High Flux Engineering Test Reactor"]

[Text] Abstract

The utilization of our high flux engineering test reactor (HFETR) is briefly introduced. In addition, the comprehensive utilization of an HFETR is discussed based on an economic analysis with a typical load.

Key words: HFETR, typical load, economic analysis

I. Utilization of HFETR in Operation

The primary function of the HFETR is to study [the effect of] radiation on reactor fuel elements and materials. In addition, it is also used to produce isotopes. Since it was officially put in high-power operation on 16 December 1980, as of 22 December 1987 it had successfully made 16 runs. Its total thermal output was 25,060 MWd [megawatt-days]. It consumed 309 boxes of fuel elements, 40 boxes of associated elements, 69 beryllium blocks, 14 associated beryllium blocks and 1,051 radiation targets.

1. Fuel Element Utilization

During the early, middle and late stages in the first run, overload testing was done on the HFETR. Surface thermal load of the fuel element reached 3.56 MW/m^2, exceeding the technical specification for the fuel elements produced in the first and second lot. This created the condition for the economic use of fuel elements. In the second run, an experiment was done to increase the depth of fuel consumption. The average consumption per box of fuel element was as high as 44.8 percent. The average consumption for elements unloaded was approximately 42 percent per batch, which is significantly higher than the design specification of 34 percent. This is an effective measure for the

economic utilization of fuel elements. From run number 1 to 16, as the radiation load increased, the number of fuel elements loaded per run also gradually rose from 25 to 57 boxes; however, the number of new elements used in each run did not increase much. The primary source is to recycle elements already used in one or two runs. The thermal output increased significantly in each run, from 1110 MWd in the first run to 2020 MWd in the 16th run. This is a result of increased fuel consumption depth and lengthening of the useful lifetime of an element.

2. Status of Radiation Assignments

A variety of testing assignments were completed with the HFETR. In order to improve the degree of utilization of core radiation space, the number of large and small targets and the number of devices increased from 11, 9 and 1 in run number 1 to 35, 58 and 8 in run number 16, respectively. The increase is over 200 percent. A total of 1,051 targets were installed in the 16 runs. A large target occupies a grid element. A small target occupies a hole in a beryllium block, a hole in an aluminum block, or a hole in an element. A radiation device occupies a radiation channel.

The kinds of radiation studies in the first 16 runs include those on fuel specimens, materials, isotopes, and other studies.

In the radiation study of fuel elements, because we did not build an experimental loop when the reactor was being constructed, the first high-temperature, high-pressure test loop has not been put into operation. The study remains in the stage of single-rod test and fuel specimen radiation in the pile. Items tested include single-rod radiation of uranium dioxide and combustible toxic fuels, as well as irradiation of a thorium dioxide sample.

In radiation study of materials, [two modes] are irradiation inside the reactor and temperature controlled irradiation in a narrow passage. The latter is the principal mode which is also technically more difficult. The high neutron flux provides a favorable condition for material irradiation. However, the high heat radiation brings difficulties to the design of the radiation device. We have successfully solved the problem by enhancing heat transfer and developing a container which is cooled from two sides and a radiation device which is cooled all over. In the first 16 runs, the reactor was used to irradiate power reactor materials such as A508-3 steel, S271 steel, fast reactor steel, zirconium-4, boron-10 stainless steel, boron-doped stainless steel, cadmium-plated stainless steel, and beryllium samples. In addition, the reactor was also used to test transducers, new thermocouples, PT detectors, rocks and high-purity silicon specimens.

A great deal of progress has been made in isotope production. The primary products include: (1) ^{60}Co sources; over 100 1.11×10^{8} MBq [million becquerels] medical sources, and 2.22×10^{10} MBq industrial sources and treatment sources have been prepared; (2) ^{113}Sn - ^{113m}In isotope generators; over 700 generators at 1110 - 5550 MBq in intensity have been manufactured; (3) ^{99}Mo-^{99m}Tc isotope generators; (4) high-ratio ^{14}C isotopes; and (5) ^{192}Ir flaw-detection source. Furthermore, targets for the production of isotopes such as ^{55}Fe and ^{63}Ni have been irradiated in the reactor.

In the area of neutron transmutation doping of single-crystal silicon, there was an increase in recent runs. This technique was used to irradiate 2.4 tons of materials in runs 14 to 16 alone. This cannot be separated from the segmented operation plan for the HFETR adopted in 1987.

Significant progress has been made in the study of gamma radiation of used elements. Our study showed that the gamma radiation intensity of an element 6 months after it was removed from the HFETR is equivalent to that of a 2.1×10^{10} MBq ^{60}Co device. A device has been built using unloaded elements for radiation cross-link of over 30 tons of polyethylene with good results.

In addition, the HFETR was also used in neutron activation analysis and irradiation of transplutonium elements.

II. HFETR Radiation Cost Analysis

When a task is assigned to an engineering experimental reactor, cost considerations are unavoidable. The cost primarily includes radiation cost, device cost and testing cost, with most of the cost associated with radiation. It is closely related to the technoeconomics of the operation of the reactor. Therefore, this section will address only the radiation cost of the HFETR.

In the economic analysis of radiation of nuclear power plant fuel elements in an HFETR based on a typical loading scheme (16 boxes of new elements in an inner layer of the active region; 16 boxes of used elements in the outer layer; 4 boxes of ancillary elements; 65 beryllium blocks; and a number of cobalt targets, absorbers and channels as specified in Table 1), a statistical unit radiation method was used.

In an engineering test reactor, the product of radiation space, neutron flux and radiation time can be used to express its radiation capability in a radiation unit which is equivalent to 10^{21} $(n/cm^2) \cdot cm^3$. After the loading scheme for a specific run is determined, we can calculate the number of radiation units. In addition to using space, time, and neutron flux to express the extent a device or target occupies the reactor, a nuclear coefficient is introduced to reflect the effects of its nu lear characteristics (such as absorption, fission and scattering) on the reactor (such as flux variation and reactor change). To simplify the situation, these coefficients are assumed to be 1. Based on the typical load, the radiation capacity is calculated to be 1.239×10^5 radiation units.

It is also possible to calculate the operating cost per run. In order to simplify the calculation, only fuel elements, beryllium, utilities and maintenance expenses are included in the operating cost. Depreciation and wages are not included. Thus, a typical load consumes 16 boxes of elements at 130,000 yuan per box and two boxes of ancillary elements at 60,000 yuan per box. The total cost of the elements is 2,200,000 yuan. It also consumes 504,000 yuan of beryllium, 284,000 yuan of water and electricity, and 50,000 yuan of maintenance. The total cost is 3,038,000 yuan.

Table 1 lists various radiation devices and targets and estimated cost for a typical loading.

Table 1. Radiation Cost Analysis

Radiation space: Name	Radiation space: Number	Radiation units $x10^4$	Total units $x10^5$	Operating cost in 10^4 yuan	Cost in yuan per radiation unit	Cost per run in 10^4 yuan
Beryllium channel	65	1.529				37.46
Aluminum channel	40	0.199				4.88
Large Co target	15	3.974				97.36
Absorber with Co control rod	8	1.895	1.239	303.8	24.5	46.43
ϕ63	4	1.881				46.08
ϕ230	2	0.972				23.82
ϕ120	2	0.265				6.49
ϕ150	1	1.678				41.10

Based on the above, we can conclude that:

(1) The cost per unit of radiation gets lower when the useful space of the reactor is better utilized with more targets and devices.

(2) For a specific task, its economics is determined by the rate of utilization of the rented space and time.

(3) The primary part is fuel cost. Increasing fuel consumption depth and reducing element cost will have an impact on lowering radiation cost.

(4) In the typical load described above, the power station element test channel (ϕ150), material irradiation channels (ϕ63) and large Co targets bear most of the cost.

(5) Using the same scale, i.e. cost per radiation unit, HFETR is lower in cost than JMTR [Japan Materials Testing Reactor] in Japan.

In Japan, JMTR has two different radiation prices. For domestic research and development projects, it charges 19,800 yen per radiation unit. For domestic profit-making and foreign projects, it is 29,800 yen. Considering the exchange rate between the Japanese yen and the Chinese yuan, JMTR charges more than an order of magnitude higher than HFETR. Despite this situation, HFETR is still too expensive for us in isotope production and radiation study of fuel elements and materials. This is because our reactor engineering R&D budget is too low and isotopes are sold too cheaply.

If the depreciation of the HFETR is 1,350,000 yuan per run and wages and benefits are 400,000 yuan per run, then the operating cost would increase

from 3,038,000 to 4,788,000 yuan each run. Correspondingly, the unit radiation cost would increase from 24.5 to 38.6 yuan. This is still much lower than the JMTR prices. However, for Chinese users it is too high to bear.

III. Opinions on Comprehensive Utilization of HFETR

1. Maximize Reactor Core Space Utilization Factor Through Comprehensive Utilization

All areas, including the high-flux element region, medium-flux beryllium reflection layer zone, and low-flux aluminum layer zone, should be fully utilized. The focus is placed on the irradiation of power plant elements and materials. Other assignments such as isotope production should be properly scheduled. In addition to domestic business, we should solicit business from other countries to ensure full utilization of space.

2. Increase Number of Runs per Year To Improve Time of Utilization

Until 1986, the reactor only made two runs per year. This was the lowest requirement. The cycle is too long for high-flux irradiation of materials and for the study of fuel elements of high depth of consumption. In addition, it is not good for the production of isotopes and some civilian products. For example, there is significant decay loss of ^{60}Co inside the reactor. It is difficult to reach a higher ratio. It is hard to guarantee a continuous supply of ^{99}Mo-^{99m}Tc and single-crystal silicon. In 1987, we had 3 runs and each run was divided into 3-4 segments to solve these problems. We will continue to operate in this manner in the future.

3. Strengthen Radiation Technology Research

It is of great long-term significance for increased reactor effectiveness that research on radiation technology be strengthened. The key area ought to be radiation devices and the associated testing techniques. We should intensify our technical cooperation in this area.

4. Perfect Associated Research Facilities

The effectiveness of an engineering test reactor is not only determined by its own characteristics but also by its associated research facilities. The HFETR main building is equipped with various experimental facilities. Based on the original plan, a total of nine water-cooled, air-cooled, and sodium-cooled experimental loops can be constructed. For a variety of reasons, only a high-temperature, high-pressure water loop was built. This is far less than what we need in radiation research. Since the Chinese government has decided to develop nuclear power independently, we should build another high-temperature, high-pressure water loop and two simple gas loops. They will be used in the radiation study of fuel elements of a pressurized water reactor and core structure materials, respectively. From a long-range point of view, we should also begin designing and constructing a sodium-cooled loop and a high-temperature gas-cooled loop, in order to carry out research on sodium-cooled fast reactors and high-temperature gas-cooled reactors. In

addition, we need to improve radiation inspection equipment, especially higher-performance measuring instruments and experimental equipment for hot cells and semi-hot cells.

5. Utilize Unloaded Elements

The unloaded HFETR elements are intense gamma radiation sources. Spent fuel elements were used to build a device to study crosslinking of polyethylene. It is in small batch production. On this basis, we should expand the capacity and increase the number of products to be processed.

Another application of unloaded HFETR fuel is to recycle it for low-power reactor use. The thermal load of a low-power reactor element is one order of magnitude lower than that of an HFETR. It is not only technically but also economically feasible to install unloaded HFETR elements in a low-power reactor to increase fuel consumption. The low-power reactor is currently being modified; we must finish it as soon as possible to enjoy its benefits.

6. Reduce HFETR Element Cost and Beryllium-Block Cost to a Reasonable Level

The costs for the first batch of HFETR elements and beryllium blocks were 130,000 yuan/box and 140,000 yuan/piece, respectively. These prices were reasonable then after taking the development cost into account. After solving all the problems and stabilizing product quality, the cost should be lowered to a reasonable level. If we can reduce the cost of elements to 70,000 yuan per box, control-rod ancillary elements to 32,000 yuan each, and drastically lower the cost of beryllium block, then each run will require 1,184,000 yuan for elements and 288,000 yuan for beryllium blocks. The entire operating cost would be 1,806,000 yuan, and each radiation unit would cost 14.6 yuan. Compared to the present price, this would be a reduction of 40 percent. Therefore, a cost reduction in fuel elements and beryllium blocks can significantly lower radiation cost, and would have a big impact on the full and effective utilization of the HFETR.

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